HOW TO SET UP PRODUCTION CONTROL FOR GREATER PROFITS

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HUGO DIEMER

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HOW TO SET UP PRODUCTION CONTROL FOR GREATER PROFITS

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PREFACE

One of the most disturbing elements in industry is "distress" merchandise. To a very large degree this grows out of ignorance of market conditions. Another factor, however, is lack of inventory control in the production of raw materials and manufactured products.

Careful observation indicates that almost without exception plants carry too much in raw material inventory, in process inventory and in stock. This tends to tie up capital unnecessarily. This frozen capital should be released for more fruitful purposes.

Intelligent production control not only reduces inventory, but it is a potent influence in expediting production and keeping costs at a minimum. Herein lies the goal to which Colonel Hugo Diemer points in the succeeding pages. All of the material is not new. Some of it has appeared in recent issues of FACTORY *and* INDUSTRIAL MANAGEMENT and its affiliated journals.

This is the first time, however, that this material has been brought together within the covers of one book—a handbook, as it were, and carefully edited into case material to illustrate every step in modern production control.

Colonel Diemer needs no introduction to production executives. He has worked among them for years right on the firing line. As an engineer, teacher, and writer, he has made a genuine contribution to the science and art of management.

The years immediately ahead call for the most intelligent control of production. No management can afford to tolerate waste, whether it be due to faulty design of product or "dead" inventory due to lack of control records. Some form of visual production control, suited to the peculiar needs of each business, must be developed and applied continuously.

The editors of FACTORY *and* INDUSTRIAL MANAGEMENT recommend this book to its host of readers who are responsible for results in industry.

JOHN M. CARMODY,
Editor, FACTORY *and* INDUSTRIAL MANAGEMENT.

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PART I

BASIC PLANNING FOR PRODUCTION

I

BASIC PLANNING FOR PRODUCTION

I. CONTROL IN GENERAL

1. Determination of Objectives Reasonable of Accomplishment.

What is it that a management is aiming to do when it plans to set up control policies, procedures and systems? Practically speaking, the management wants to know certain things very definitely. Next, they want to have the administrative machinery necessary to direct and carry out in the most effective way the actions which policy indicates are appropriate in accordance with the facts brought out. Outstandingly the prime objective is profits for the business. Secondarily but of almost equal importance is satisfaction to all involved, including employes, executives and customers. A management has the right to expect a clear-cut presentation of the business picture which it must study. It wants an equally clear picture of what the plant, its administrative, operative and functional organization consists of. It wants to know whether the quantity and capacity of personnel and equipment and their cost are in line with present day conditions and competition.

2. Codification of Policies.

A sales or manufacturing program that calls for either a decided increase or a decided decrease will necessitate certain management policies. These policies may relate to such matters as employment, as to hours of labor, as to selling methods, as to financing, etc. It is important that these policies be definitely agreed on in the first place by some responsible body such as the executive committee of the Board of Directors. Policies should be as carefully constructed and drawn up as a contract so that there can be no question as to their meaning. They should be recorded in the minutes of the executive committee. They should be transmitted to all executives responsible for carrying them out. If there is a central repository for filing the company's general organization procedures, the codified policies should be kept in file in such repository. A complete set of codified policies covering all matters into which policy enters is as important as a complete set of organization procedures and instructions. They should be reproduced in sufficient quantity to supply a copy to every executive responsible for the carrying out of policies.

3. Preparation of Programs Based on Analysis and Forecasts.

A management should know very definitely the amount, the cost and the present value of its inventories of all sorts and the extent to which they are applicable to current and future programs.

A management should know just what it has sold during each past year and during each quarter. Also what its profits and losses were on the various classes of product. A management should be able to forecast within reasonable limits of accuracy a sales program for a year ahead and within very close limits a program for the next quarter. From these forecasts it should be able to prepare an approximate manufacturing program for the year and a very definite manufacturing program for the next quarter.

A practically worked out system of production control should make it possible to plan purchases, payrolls and manufacturing schedules with accurate predetermination of costs for the current quarters. It should also definitely schedule priorities and times of completion for all current orders on hand.

4. Planning the Organization to Carry Out the Programs.

Planning the organization to carry out effective control involves at the time of its initiation such problems as re-assignment of duties or transfer of responsibility and possibly the employment of new men or outside consultation service. One of the outstanding purposes to be accomplished is the reduction of unit costs. If proper control will materially decrease losses and wastes as it is expected to do, the company may feel justified in increasing the administrative overhead factor with the hope that the unit cost of production will thereby be reduced. Wherever it is possible to distribute control duties to men already in the organization it is preferable to build up the control organization in this manner. In most cases this can be done. Of course, if the company does not have a competent industrial engineer on its staff either with or without such title, such ability will have to be injected into the organization either by the employment of a competent full-time engineer or by the employment of a consulting firm. If the latter plan is adopted a part of the installation should be the selection and training of a company man to be the permanent industrial engineer. Most companies now-a-days have in their employ men who are making a study of industrial engineering and industrial management. A little investigation will usually disclose that there are capable men who are faithfully studying along these lines. It is likely that such men are already members of national organizations devoted to such study. It is well worth while for a company to make a survey of its force to locate these men and to make use of their preparation and abilities.

In general, a roughly sketched outline of an organization for control will include such functions as are centered in a director of the budget, a director of sales research and market analysis, an industrial engineer, a director of planning and production control, a director of time studies and methods engineering, and a director of personnel. These functions are usually separate from and in addition to the functions of the general manager, the works manager and the plant superintendent.

An organization survey and study should cover the cost of salaries and clerical assistance required for a control organization in order to determine just how far a company can afford to go and still make the expense of such an organization an investment for greater profits.

5. *Preparing Definite Procedures to Be Followed in Order to Reach Objectives and to Carry Out Policies and Plans.*

Fitting the control mechanism to a particular industry requires ability, adaptation and simplification. Only those system mechanisms and records are to be used as will get the results wanted in the simplest manner and at the least cost. There must be no unnecessary records or statistics. One can readily see how complicated some of the mechanisms in use are by getting from the various manufacturers of filing devices tabulating and bookkeeping machines, etc., sets of forms as are used in various companies. It is possible that some of these may furnish valuable suggestions as to design of systems appropriate for the company just making an installation. They should also be closely inspected, however, from the point of view of seeing what can be eliminated. A careful perusal of the subsequent content matter of this volume will disclose what are ordinarily the most essential records and what departments should keep them.

6. *Analysis of Reports of Accomplishment.*

Progress reports on such matters as conformity to budgets, conformity to schedules, and conformity to predetermined costs, should be regularly and carefully inspected. Failures to reach the standards set up should be closely investigated to determine costs, and where necessary, corrections should be made in such cases where the standards as set up are unattainable. It requires skill and good judgment to determine where this is actually the case. It frequently happens that heads of departments that are very inefficient are quite capable at argument.

7. *Recognizing and Rewarding Accomplishment.*

Where certain individuals consistently show inability, transfers should be made. Where certain other individuals consistently show proficiency, adequate recognition should be accorded without undue delay, by promotion and advance in salary commensurate with the results attained. Such appreciation may well be accompanied by the formality of a personal congratulation on the part of the next higher executive rather than through the medium of a house memo. The personal touch has always a morale building effect.

8. *Correlation of Controls in the Major Divisions of Business.*

A control committee would normally include certain directing officials serving ex-officio, such as the general manager, the production manager, the sales manager, and the general superintendent. The active members of the direction will be director of the budget, the director of sales research and market analysis, an industrial engineer, the director of planning and production control, the director of time studies and methods engineering and the director of personnel. In a small company some of these functions may overlap. However, if a company employs upward of 500 men and does a business upward of $1,000,000 a year, each of the individuals named can function to advantage as a separate individual and help the company towards making greater profits. Such a committee should meet monthly and consider reports of each of the active control heads. These reports should be distributed and studied by each member of the committee before the meeting. The meeting can then actively consider suggestions for correlation and improvement.

II. FORECASTS AND PROGRAMS

9. Analyzing Typical Past Monthly, Quarterly, and Annual Manufacturing Programs and Eliminating Unusual Factors so as to Develop Normal Expectancies.

If there have been no manufacturing programs constructed during past years, the records as to what was produced and what was shipped can be obtained from the shipping records, as to finished goods shipped, and from cost and stock records as to goods manufactured and put into stock. From these records, past manufacturing programs by quarters and years can be built up together with separately constructed sales and shipping programs.

An analysis of these past programs will disclose that there are probably certain items which are out of the ordinary, and which it is not reasonable to expect should be repeated. After eliminating the unusual items, we have a basis for constructing the expectancy for the next year and its various quarters.

10. Comparing Sales Departments Advance Prediction for the Coming Year, by Quarters, with Past Normals.

A good method of preparing past production methods for comparison with future programs is to plot the production of each major product graphically, by months. On the same chart is next plotted the cumulative total. A third curve is now added which is the cumulative average or tendency curve. This cumulative average consists of the cumulative total divided by the number of months. If this curve shows an upward tendency during the year or for several years, it is likely that in a normal year this curve will continue at the same tendency.

In order to get a complete picture, similar charts should be prepared covering shipments, materials on hand, work in process, and finished products in stock. A careful study of the facts indicated by these charts, in connection with the sales department's predictions, will be a valuable aid in setting up the production program for the coming year, and its quarters.

11. Considering General Economic and Business Forecasts as They May Affect Production.

A number of companies furnish monthly forecasts of business and economic conditions. Among these companies are Babson's

Statistical Organization, The Brookmire Economic Service, Harvard Economic Society, LaSalle Extension University, The Cleveland Trust Company, The Irving Trust Company, The National City Bank, The Continental Illinois Bank & Trust Company. The American Management Association publishes a monthly summary of the opinions given in these various publications, under the headings of: General Outlook; Money and Credit; Security; Markets; Production; Distribution; Building; Agriculture; Commodity Prices; Foreign Trade and Conditions; Labor and Wages.

A careful study should be made of these forecasts in preparing a manufacturing program for the year and for each quarter. As an example of what such studies might bring up, we might take a glance at some of the features of the first quarter of 1930, which presents a rather unusual aspect as compared with previous quarters.

Comparing the first quarter of 1930 with the same period in 1929:

Employment dropped 9 per cent.
Payrolls dropped 13 per cent.
Automobile production dropped over 30 per cent.
Ford and Chevrolet made up 65 per cent of all auto sales.
Department stores sales dropped 6 per cent.
Sales of shoes dropped 21 per cent.
Sales of women's wear dropped 14 per cent.
Checks cashed outside of New York City showed a drop of 12 per cent.
Railroad earnings showed a drop of nearly 25 per cent.
Freight car loadings dropped 9 per cent. (Regional Advisory Boards estimated 2nd quarter would run 4 per cent below 2nd quarter of previous year.)
Business failures exceeded previous years by 18 per cent during the first quarter, there being more insolvencies than in any first quarter since 1922. April showed an improvement, the failures in April, 1930, showing 13.8 per cent increase over April, 1929.
Commodity prices averaged 90 per cent of previous year.
Exports dropped 23 per cent while imports dropped 10 per cent.

Somewhat offsetting these declines were the large programs for 55 per cent increase in public building construction, and 20 per cent increase in road construction over 1929, which were expected to give employment not only to the workers in construction operations, but were expected to affect also the industries manufacturing machinery and equipment for construction work as well as those furnishing the essential materials and supplies required.

More important than totals are trends. Is activity increasing or declining? Just as important as knowing where we are, is knowing in what direction we are going. At any time some lines will be found to be declining, while others are increasing. This viewpoint of watching trends is especially important in our consideration of activities in abnormal periods. During 1929, operations in many lines were approaching a peak and were ready to start on a sharp decline. During 1930 totals were not as high as in 1929 but where the trend is upward the outlook is for increased business.

12. Considering Regional and Local Growths or Depressions as They Are Likely to Affect the Specific Industry Studied.

Some of the publications mentioned give maps and tabulations showing conditions in the various geographic centers of the country. In addition to a study of the local conditions as set forth by these national publications, it is desirable that the branch sales managers of a company in various parts of the country, make a quarterly survey of conditions and trends in their territories as they consider they will affect the next quarter's business of the company, and send these into the headquarters office in the form of a quarterly report or filled-out questionnaire.

13. Utilizing Government and Trade Association Data and Services.

In the application of investigations to distribution, business makes use of the returns of the Bureau of Census, Bureau of Foreign and Domestic Commerce and the Bureau of Standards. The Bureau of Census conducts not only the decennial census (the latest being 1930), but five-year inquiries covering manufacturers of products; and annual inquiries on financial statistics; also monthly inquiries on products, stock and orders for a number of commodities. Some market investigators study also such matters as incomes, magazines subscribed for or bought, automobiles registered and makes, employment distribution, educational institutions, etc., the purpose being to determine the buying power of different classes of people.

A number of trade associations are supplementing the census statistics by maintaining statistical departments which collect and distribute the important statistics relating to their trade associations. The U. S. Chamber of Commerce issues a pamphlet on trade association activities which details what they are doing along the lines of commercial research and statistics, cost accounting, credits and collections, public relations, simplification and standardization, traffic and transportation, and trade ethics.

Such trade associations frequently employ a competent industrial engineer in an important position of the association, to determine the nature of the investigations and statistics of the association.

The progressive manufacturer, jobber, or merchant will take full advantage of membership in such associations as will give him the market statistics which will guide him in his policies.

III. TYING UP BUDGETARY CONTROL WITH THE PRODUCTION DEPARTMENT

14. Establishing Units of Measurement for Estimates.

Having determined on the approximate sales and manufacturing programs for the year, in order to determine a general budget it is necessary to translate these programs as they affect all of the various departments of the business, into estimates covering the cost of carrying out these programs and plans. The various department heads are expected to work out estimates for their departmental budgets covering the controllable factors of cost and expense for which they are responsible.

There remain, however, certain other allotments or apportionments of general overhead, such as fixed charges, rental, administrative expense, etc., which must be apportioned to the various departments. Frequently this apportionment is made in advance of the other items of the departmental budgets and typewritten on the departmental budget sheets which are handed out to the various department managers who, in turn, fill in the remaining estimates covering the items which they control and for which they are to be held responsible.

The unit of measurement for purposes of apportionment will depend on the part played by each department. Some of these apportionments must be more or less arbitrary, but even so, there is opportunity for the exercise of sound judgment. For example, a cafeteria or a rest room may contain as many square feet of floor space as a drafting room. Shall the cafeteria or rest room and the drafting room carry the same fixed charges, rental charges, and share of administrative overhead? How about yard storage as compared with store rooms under cover? Similar questions of equitable apportionment will have to be settled.

Next comes the question of determining what budget factors have a direct ratio to quantity of production and which ones remain fairly well fixed irrespective of the amount of production.

A company that provides plans of operations as a basis for routing and scheduling in accordance with the methods to be later described, has available the data for building up the total labor hours as well as the total machine hours involved in the programs, forecasts, and preliminary budgets. Time estimates made by the department managers are usually based on conferences with the Cost and Time Study departments.

Material estimates are not usually included in the departmental budgets, but are contained in a separate purchase budget. The material estimates are not usually taken directly from bills of materials. However, these bills of material, in connection with the manufacturing program, constitute a reference basis in connection with past purchase records for the separately constructed classification of materials by the kind of material, which constitutes the basis for establishing the purchase budget.

15. Establishing Inventory Stocks and Inventory Requirements.

The program of raw materials and component items to be purchased, is usually built up primarily from past purchase records as compared with the current programs and forecasts for sales and manufacture. It has already been stated that bills of material constitute a reference for greater accuracy. Consideration must also be given to the stores inventory with close inspection as to unallotted balance on hand and in process. This program of materials and component items to be bought, and made after due consideration has been given to the stores inventory, constitutes the basis for the manufacturing section of the purchase budget.

In a general way, the purchasing department, through its records of past invoices, has an idea of quantities required in the past which, when checked up with goods manufactured and materials still on hand in store rooms, together with inventories of materials on hand, will give an idea of materials required to cover production of a given quantity of goods. These data as to average annual consumption need to be modified in accordance with the forecasts and programs for future sales and production and their distribution by goods as compared with past programs. The natural method of determining material requirements is to multiply the quantity per unit of product as indicated on the bill of material by the number of such units called for on each production or sales order, together with such safety factor for losses as past experience indicates to be appropriate.

The production or engineering department should furnish data as to the quantity of bulk stock of various materials which must be purchased for each production order. This information can be tabulated as a part of the formal plan of material for each production order which makes it easier to forecast totals of materials corresponding to the annual and quarterly manufacturing programs.

The Purchasing Department will generally find in most businesses that it is too complicated a procedure to attempt to work any plan of purchase control predicated on use of the Individual Item Perpetual Stores Inventory Sheets. These sheets have their uses in connection with control over individual production orders and the corresponding withdrawals from stores and stores requisitions on the Purchasing Department.

The Purchasing Department is, with the aid of the Production Department, furnished a list of the items to be contracted for to meet the requirements of the manufacturing program which is usually tentative for the year and only final as prepared for each quarter 30 days in advance of the opening of that quarter.

At the start of the year, the totals under each purchase item less stocks on hand not assigned to past production orders, and less requisitions already made on the Purchasing Department in anticipation of the program, constitute quantities to be ordered by the Purchasing Department to meet programs.

Thereafter, the totals of requisitions on Purchasing Department, minus receipts should constitute open purchase orders. Also, total receipts minus disbursements, should check closely with inventories, the matter of allotments and reservations being covered by the stores accounts and not entering into the Purchasing Department's consideration excepting as cancellations or revisions of the manufacturing program, as a whole, necessitate alterations.

The Purchasing Department must, of necessity, have a simplified cumulative control, quite independent of the control by orders or lots exercised by the Production Department in co-operation with stores inventories.

16. Establishing Department Payrolls, Expenses, and Overhead in Line with Predicted Programs.

The items to be furnished by the department or sub-department manager, will include:

(a) A list of employes with their present rates, and recommended increases through the year.

(b) A general expenditure list, by quarters, in which are stated total amounts for salaries, stationery supplies, postage, traveling, and any expenses peculiar to the department but omitting materials which, as before stated, will be in a separate budget and also omitting plant maintenance items.

These are sent in and reviewed by the department in charge of the budget. This department may have determined in advance, or it may determine after receipt of the estimates, proper proportion of indirect expenses covering such items as rental, light, heat, depreciation of furniture and fixtures, etc.

The various departmental budgets in any one division are assembled into a consolidated division budget, the maintenance of which is a responsibility of the executive heading the division of departments involved.

17. Budgetary Check-Up.

The actual performance under the budget as compared with the budget allotments is prepared either quarterly or monthly in a statement presented to each department manager with a duplicate to the head of the general division in which each department is classified in the general plan or chart of the organization. This tabulation indicates the budget, the actual, and the deviation for the current period, for the cumulative period, and for the same period of the previous year. Each department manager is expected to make a satisfactory explanation of the deviation to his division manager, who in turn is held responsible for explaining deviations to the director of the budget.

PART II

CONTROLLING THE PRODUCT IN PRODUCTION

II

CONTROLLING THE PRODUCT IN PRODUCTION

IV. TYING UP ORDERS WITH THE PRODUCTION DEPARTMENT

18. Tying up Orders with the Production Department.

Customers' orders and customers' needs are the prime consideration of the order department. It is up to the order department to keep the production department informed of the ever changing status of priorities in connection with the manufacture and shipment of goods to customers. The planning and production control departments of a factory have as their prime objective the running of the shop in such a manner as to bring about smooth flow, low costs and regularity of work. The shop scheduling and dispatching is adapted primarily to these objectives. On the other hand, it is the order department's function to plan and schedule wholly from the standpoint of most satisfactory relations with customers. Hence, the order department must make such changes in daily, weekly and monthly schedules and in the manufacturing programs as will meet the customers' requirements to greatest advantage. Where there is a difference of opinion between the order department and the production divisions the general manager must make the final decision as to whether production costs or customers' needs shall have precedence. Hence, the order department should report neither to the sales department nor to the general planning dpartment, but directly to the general manager.

Business research and market analysis have been undertaken from time to time in various companies and like many other investigational activities have been dropped in times of temporary depression. If these investigational and statistical activities are centered in a permanent line department such as the order department they are likely to be continued and used during these periods,—during which periods their services are equally as important as during periods of exceptional prosperity and over-activity.

19. Order Department as Tie-up Between Sales and Production Divisions.

The production department looks naturally on its contacts with its sales division as incidental and secondary to its regular function of efficient production. The order department, on the other hand, looks on its contacts with the sales division as its most important and regular and permanent activity. The sales department stresses the selling process and looks on investigations, analyses and statistics as matters which are rather unexciting and which, if they are in the sales department, are usually either postponed or looked on as decidedly secondary since the sales department centers its attentions on the ever present and ever changing situations involved in the selling process. For the foregoing reasons the order department forms a natural connecting link between the sales department and production department. The order department maintains files of the purchases of the company's customers together with records of any complaints, delays or eccentricities of the customers. It is the order department that provides the production department with the sales programs and advance information about new orders and contracts likely to be closed. It is usually considered a responsibility of the order department to keep a schedule of promises of delivery and shipments and to keep close contact with the production department and to help that department in any way possible in the removal of interferences causing delay due to conditions outside the production department. The order department is also the department that is expected to keep the sales department informed as to any unavoidable changes in delivery dates from those originally promised. The order department is usually furnished a complete file of all production orders issued by the planning or production control departments to the shop together with scheduled times of completion. They are also furnished notices of completion of shop production orders as they are closed.

20. Translating Customers' and Salesmen's Orders into Plant Language and Interpreting Them in Terms of Plant Capacity.

It is usually the duty of the order department to receive from the sales department all contracts or orders from customers and to translate these into very definite terms so that there can be no misunderstanding on the part of the production department as to exactly what they are to make or ship. It is customary for the order department to be provided with billing machines or other devices necessary to manifold the necessary number of copies of the order so the accounting and shipping departments as well as the production department may be properly informed and have necessary authority for action in issuing their own divisional orders and plans. The details of converting orders into plans of materials and plans of operations are distinctly functions of the planning and production control departments.

21. Changing the Quarterly and Annual Manufacturing Program as Forecast into Definite Monthly Schedules.

The monthly manufacturing and shipping schedules are the result of co-operation between the order department and the production control and planning division. The order department determines the priorities of shipments. The production department determines when, where and at what rate the various operations shall be performed on such component parts and other items as have to be manufactured for customers' orders. The production department also determines how the monthly program is to be rounded out through the manufacture of stock lots. Some of these stock lots may be applicable to current shipments and some of them may be applicable to the general quarterly manufacturing program. The order department says, "Here are the shipments which must be made next month. Here is also a list of items which may have to be added to the foregoing but which are not as yet definitely in hand as orders." The production department will also be consulting the data which it has available as to the balance of work ahead at each production center, as to whether that center has a full month's quota of work, whether it is short of work or whether it has an excess of work. From these data the production department will determine whether certain production centers shall be supplied with stock work if this looks desirable from the general quarterly manufacturing program. It will also determine whether new equipment must be put in or work farmed out by contract. It will also forecast the possible shutting down of certain production centers if the general manufacturing program indicates such action as proper.

V. PLANNING PRODUCTION

22. What Centralized Planning Involves.

Comprehensive planning prepares in detail all information needed in advance of doing any work. In connection with such planning, there is one step which is often called "preparation," which means having ready everything in the way of drawings, designs, materials, fixtures, paper tickets, etc., as soon as actual work is to begin.

Ordinarily, the planning function includes the preparation of plans of materials, plans of operations, preparation of routing, scheduling, and dispatching. It should also include, as it does in many instances, provisions for check-up as to progress under budgets and under predetermined costs; also, direction over the necessary follow-up of control through departmental charts and dispatch boards.

In general, centralized planning covers the following points as they relate to each component of the work:

1. What is to be done; specify the materials, drawings, tool lists, and indicate what is to be taken from stock or stock orders, and what is to be made to order.
2. How shall the work be divided as to production orders?
3. How is work to be done? Refer to route sheets, tool sheets, etc., if already made, and if not made see that they are made.
4. What is the priority status of this work?
5. What departments and what production centers are involved?
6. How long will each step take and when is it to be done?
7. How much may each step cost, what may be the total cost, and how are check-ups on cost to be made?
8. How will emergencies, delays, or interferences be handled?

23. *Plans of Materials.*

A complete list of material requirements for every order should be prepared, either by the production or engineering departments. This material list should specify:

1. The name of the article or machine to which the plan or list applies, giving reference to catalog number and to order number on which it is being used; also the date on which this issue or addition of bill of material was originally prepared, and dates of revision. Master copies should always be kept on file indicating clearly what revisions are made and when they took effect.
2. The list or plan should give full information with regard to each item on the following points:
    (a) The name of the piece
    (b) The piece number or symbol, pattern number or symbol
    (c) The quantity required for one unit
    (d) Total quantity required for this order
    (e) Specification number

(f) Drawing number
(g) Route sheet number
(h) Tool list number
(i) Time-study sheet number
(k) Cost record number

Plans of material are most generally arranged by the assembly groups if the product is a machine. If the product is one in which several distinct shops or departments handle material which is subsequently assembled, there may be separate bills of material for each of these shops. For instance, the wheel group and body group material lists of an automobile would be ordinarily made up separately from the bills of material for the motor group and the various drive and chassis groups.

When the grouping of materials has been decided on, the materials in each group list are ordinarily listed in such a manner that all material of a given kind is listed together. For example, steel castings, iron castings, brass castings, malleable castings, die castings, bar stock products, etc., would be grouped together.

Before effective scheduling and dispatching systems were put into effect, it used to be the custom to use the bills of material as entry lists for dates and check-up in a sort of improvised rough scheduling system. Modern practice confines the plans of material to a record of the items as above listed. These material lists or plans are then run off on a ditto machine or some similar method of rapid duplication in such quantities as may be necessary for use by such departments as the balance of stores department, scheduling department, the cost department, and any other departments having to do with production control.

24. *Plans of Operations.*

Plans of operations are usually built up by assembling the route sheets of the various parts requiring shop work to be done. The first time work is done these route sheets may not be absolutely correct and may have to be modified, as experience together with time studies and the application of methods engineering in the shop may indicate alterations from the advance issue of the route sheet. The various route sheets should indicate tools or reference to tool lists and any special instructions. The completely assembled route sheets are clipped to a general instruction, usually accompanied by a chart, from the scheduling department indicating the relative rapidity of probable completion of the various parts. This chart establishes the relative starting times for the various components on an order.

25. Preparation.

This function is important enough to assign to it, in the large organization, one or more men. It is the duty of this function to check up and see that materials are ready for delivery at point of first operation; to see that drawings and tools are available in accordance with the drawing lists and tool lists; to see that withdrawal orders on the stock room are written in advance and ready to send out by the scheduling department; to see that work tickets, tickets authorizing movement of materials, etc., cost cards, etc., shipping orders, etc., are all properly written out in advance of doing the work; that the scheduling, dispatching, inspection, and cost departments are in possession of all the necessary papers and authorizations as soon as the work starts.

26. Scheduling.

The scheduling department maintains:

(a) A record of balance of work ahead at each production center.
(b) Establishes the priority of the various components of the various orders in the various shop departments.

Scheduling is usually carried down to specifications and records in which each day's work for each department is indicated in advance by dates and by hours. Ordinarily, scheduling in advance for weeks which are to follow the current week, is built up in such a way that only about 60 per cent of each day's capacity of the production center in question is built up, the remaining 40 per cent being left available for new work or urgent work which comes in.

The current week's schedule is then built up to full capacity. This may necessitate, and usually does, some slight readjustment of the advance schedules which may have had to be drawn on in order to build up the current week's schedule.

27. Dispatching.

Further details as to the operating and scheduling of dispatching will be given later in this discussion. For the present, it is sufficient to state that dispatch is the action element in control. Dispatching is usually the decentralized department control over the observances of departmental schedules and priorities. In many organizations this means that there is a dispatch clerk, a dispatch board, and an assignment board for every distinctly set up department or group of departments having a single supervisory head. Dispatching necessitates close contact between the supervisory head and the machines and workers in the department. The dispatching function includes the locating and removal of all causes for delay or interferences.

The movement of materials from operation to operation, as well as materials coming into and out of the department, is also a duty of the dispatching function.

It is also usually the responsibility of the dispatching clerk to see that time entries on work tickets or time tickets are correctly made. In many companies the dispatch clerk's desk is provided with one or more time clocks to which the men come when they turn in their current work ticket and get the next work ticket.

28. *Inspection.*

Inspection is usually designated in the plans of operations, which state when and where inspections are to be made, designating also whether the inspection is 100 per cent or selective. Inspection centers are usually placed in a shop in such a manner as to be convenient to the most ordinary flow of worked materials through the shop. It is usually the dispatcher's function to see that materials get to inspection and return from it in accordance with schedules.

29. *Check-up.*

Wherever it is possible to catch indications of what looks like over-running costs, especially in the case of a long run of materials, such matters should be promptly called to the attention of the head of the production control department.

VI. PLANS OF MATERIAL AND MATERIAL CONTROL

30. *Effective Material Lists.*

Preparation of a complete bill of material for each manufacturing order is only one typical example of the application of the principle of standardization in manufacturing. The man entrusted with the preparation of the bill of material must be able to determine, not only what is the best material, but also what is the practicable and the most expedient material to specify.

The engineering or drafting room specifications of a completed article will list the component parts and indicate of what material they are to be made. In making up a bill of material for a machine, for example, there will be some parts that are made from steel castings, some from iron castings and some from brass or copper or aluminum castings, and possibly some die cast parts. The castings are easily disposed of since the material, so far as quantity is concerned, is taken care of by the foundry making the castings. There will, however, be also some parts to be made out of bar stock, such as machine steel, cold rolled steel, brass or copper bars. There will also often be punchings and brass work involving the use of sheet metal. The man who prepares the bill of material will have to know the commercial dimensions of such materials and will have to specify the units expressed in the total number of linear feet of bar stock and square feet of sheet metal stock of the proper dimensions or gauges. He will have to be familiar with the kinds of such material usually carried in stock by the company, itself, and by the company's usual suppliers who can furnish the materials needed on short notice.

Similarly, in the matter of such articles as are classed under the general head of fastenings, namely: screws, bolts, rivets, etc., he will have to know how to select standard articles easily obtainable to take the place of dimensions and threads which may be correct from an engineering standpoint, but which may be unusual from a commercial standpoint.

In the matter of parts made of such materials as wood, rubber, fibre paper or textiles of different kinds, he will have to be in possession of some information as to what is carried in stock and what is easily obtainable in the market that will answer the purpose. He will then have to make due allowances for unavoidable wastage in the shop operations necessary to make the items of the dimensions wanted, and designate the correct quantity required for the order or lot in question.

It will be evident at once that it is unnecessary to go through all these processes of getting the desired information for each and every order if a complete record is being made the first time.

31. Accurate Specifications.

A common experience of the man who is preparing the first set of bills of material in a manufacturing plant, is the loose way in which materials are specified. For instance, cast iron is simply c.i., bronze is simply br., brass is b., machine steel is m.s., cold rolled steel is c.r., etc. The absence of definite data with regard to chemical, physical, and other specifications, gives too wide a latitude to a purchasing department. There is usually a lack of definite specifications with regard to fastenings, such as machine screws, bolts and rivets, and bar metal stock. Specifications can be referred to by number.

Some of our railroads have been working for a number of years on preparation of definite technical specifications covering materials required and used by them. One of the engineers on this work stated that they had been on this work fifteen years and still had only about one-half of their materials under definite specifications, so one can see the magnitude of this work in an undertaking such as a railroad company. Even when definite specifications have been prepared they are always subject to change because of the progress being constantly made in the development of better and different materials.

When we once know the quantity and kind of materials that are required for the products which are to be manufactured, we are in a position to furnish basic information which, with further statistics, enables us to organize our purchasing and stores department systems so as to provide for material control.

Dr. Chas. B. Dudley, past president of the International Association for Testing Materials and the American Society for Testing Materials, prepared the following rules for the guidance of those who are preparing specifications for materials:

1. A specification should not attempt too much nor be too complicated.
2. Well-known methods of analysis or testing should be referred to only in a general way.
3. Well-known precautions to be observed by the inspector should not be explained in detail.
4. New methods of analysis or testing, not well known, must be described in detail, or reference must be made to the original publication.
5. Analyses like those of soap and oils, which are not conducted in the same manner by all chemists, should be issued in separate pages and made a part of the specifications.
6. When drawing up a specification do not incorporate in it all you know about that particular subject.
7. Do not put too many restrictions into the specifications, but state as few tests as are necessary to yield the product required.

8. Do not make the limits too severe. If you tie the manufacturer down to the extreme limit, you place him in absolute antagonism.
9. It is better to specify a good average material, and get the necessary protection of machines and processes by a more liberal factor of supervision and technical knowledge, rather than to insist on extreme limits, which can only lead to constant friction and a demand for concessions.
10. Do not think that the most perfect specimen of a certain product should be made to represent the total output of the works. The use of such extreme figures is one of the worst possible mistakes observed in some specifications.
11. All parties whose interests are affected by a specification should have a voice in its preparation.
12. The limitations contained in a specification may be derived from any source of knowledge, and the tests may be microscopic, physical or chemical.
13. The specification should contain all the information which is needed by those who are to enforce it. This includes the chemist, the engineer, the purchasing agent and the superintendent.
14. The service which the material is to perform, in connection with reasonable possibilities in its manufacture, should determine the limitations of a specification.
15. Proprietary articles and products made by processes under the control of the manufacturer cannot be made the subject of specifications. The consumer, however, may determine the chemical and physical properties of any preparation and incorporate these in a specification.
16. The sample for testing must always be taken at random. The amount of material represented by one sample must be determined by the nature of the material, its value, its probable uniformity, and its importance.
17. Average samples, made up of a number of samples, should only be prepared in cases where the limits of the specifications are so narrow that they do not cover the ordinary irregularities of good practice in manufacture.
18. Retests of material which has once been rejected should be allowed only on very good grounds. They are justified when there is a doubt as to the exactness of a test.
19. If it is desired to sell rejected material to a consumer, after it has been rejected by him, a concession in price must be made.
20. When a consumer has purchased material on specification it is unfair to ask of the manufacturer guarantee of the behavior of the material in service.
21. It should as a rule be unnecessary to mark rejected material when dealing with reputable firms, but if this is necessary, an inconspicuous private mark may be applied. In any case the manufacturer should be obliged to pay return freight on rejected goods.

22. Specifications should be examined, and if necessary revised, six months after they have first been put into force. This makes it possible to introduce the knowledge gained by actual usage.

23. In testing materials, if the results are just outside of the prescribed limits, allowance should be made for error.

24. A complete workable specification should harmonize the naturally antagonistic interests of producer and consumer. It should have the fewest requirements consistent with securing satisfactory material; should leave no chance for ambiguity; and above all, it should embody the results of the latest studies of the properties of the material.

32. *Comparative Statistics and Computations.*

We have indicated in paragraph 15 how the purchasing department secures data to develop the general purchasing and purchase contract program. These programs must be flexible enough to adjust themselves to the more specific programs of the Planning and Production Control Division which are based on a tie-up of bills of material covering current production order with the data shown on the perpetual inventory sheets.

It devolves on the Planning and Production Control Department to establish the most economical manufacturing lot sizes and also the most economic individual purchase order lots. Establishing the proper purchasing lot size involves determination of the minimum stock to indicate the ordering point. Theoretically the new material should arrive just when the existing stock is exhausted but actually a reserve must be allowed as a safety factor to meet delays in delivery and emergency or rush production orders. The practical minimum will therefore have to be an adjustment to fit each item of stores.

The amount of money involved and shipping costs and remoteness or nearness of supply will determine whether the ordering lot will cover a week's, a month's or a quarter-year's supply of any one item. A well known soup factory adjoins a can manufacturing plant. One day's supply of cans is ordered daily. Such a condition is the exception but illustrates the point.

Where stores items are manufactured for stock in the shop itself consideration must be given to such matters as the allotments of this item to sub-assemblies and to service or repair stock shipments, also to the cost of set-up and preparation and the effect of a long run not only on costs of this item but on the availability of the equipment involved for other needed items.

A long run may materially reduce unit costs on an item, but not only will interest on investment and storage costs increase but there is a likelihood of much greater loss by delaying operations on other needed items by putting a long run on machines which are needed for meeting schedules. Long runs are most appropriately taken care of during seasonal inactivity. For such occasions those parts should be put on long runs which offer the biggest savings in quantity production. Ordinarily the limits are imposed by the requirements for the item in question as indicated by the manufacturing program of the current month and quarter.

Various authors have developed mathematical formulae for figuring most economical purchasing and manufacturing lots. This aspect of the matter may be gone into with advantageous results when the investigators are competent not only from a mathematical but a practical point of view. Caution should be exercised, however, in the use of empirical formulae as a routine tool of order clerks.

33. Provision for Waste and Scrap.

Sometimes the quantity listed on the bill of material covers the normal and unavoidable wastages, leakages, etc., such as are involved in cutting wood, metal strip, etc., or measuring out japan shellac, etc., sometimes not. Such wastage can and should be accurately predetermined. It is all well and good to say we will have to investigate the causes of these losses and wastages and avoid them. That is an undertaking which, although desirable, is something which is almost always deferred to a more opportune time. Hence, it is wise in providing for material requirements to allow a sufficient factor of safety to cover the excess indicated by experience. Otherwise, you will find yourself suddenly without some very essential material.

34. Graphical Charts.

Probably the best remedy for a situation of this kind is some type of control which checks withdrawals against reservations. The Gantt chart is frequently used for this purpose.

In the use of the Gantt chart for summary purposes, we may indicate quite a wide variety of information. For instance, we may show:

1. Requirements by periods of time, and total requirements.
2. Contracts placed to meet these requirements and total amounts contracted for as compared with estimated requirements.
3. Deliveries in each period of time as a percentage of requirements and the total amounts delivered.
4. The amounts issued in each period of time and total amounts issued.
5. The requirements that have been covered by contracts as against the delivery for the same period of time.
6. The required amounts used according to and compared with the amount that should have been used.
7. The amount still to be contracted for against the amount delivered on contracts.
8. Withdrawals from stores compared to withdrawals planned for.

In short, the Gantt chart may be used where the length of a line may be used to show a standard, and the length of another line used to show actual performance for comparison.

35. Perpetual Inventories.

It is, of course, a foregone conclusion, that the basis for these graphical charts is to be found in an accurate and up-to-the-minute system of perpetual inventory, coupled with proper physical store room layout, material handling, equipment and disciplinary control over methods of storage in bulk and storage in bins of all materials, wherever located.

The records and systems should disclose not only for each item of material the quantity on hand, due on outstanding purchase orders, reserved for production orders, issued on requisitions, and balance deducting allotments, but also the following essential data:

(a) Monthly requirements accompanied by seasonal fluctuations for the various materials.
(b) The most favorable sources of supply.
(c) What time is consumed for the supplier to fill an order plus the time in transit.
(d) Aside from consumption demand other facts such as price discounts and trade considerations which tend to establish the most advantageous purchasing unit.
(e) In case of emergency, the alternate or substitute material or finished product that can be used, and the additional expense or other disadvantage involved in such a substitution can be shown.

It may be found desirable to have the above data posted on the back of the existing perpetual inventory records. Where conditions are identical for a certain number of items, the remark "same as ————" will save entering the same item a number of times.

Where a company is of sufficient magnitude to have a planning department, control of materials with a view to ordering materials required for production in proper quantities at proper times and seeing to it that inventories are maintained at a minimum amount, practically constitute a part of the materials supervision exercised by the planning department. Where this is the case the stores department, proper, will concern itself primarily with such matters as seeing that proper accounting is kept of all materials received and disbursed and that all materials are stored in safe and convenient places, in appropriate bins or files with proper indexing of location.

The head of the stores department will see to it that the store room is properly maintained with adequate fixtures, proper lighting, and competent help in the way of attendants to see that the right materials are delivered to the right persons.

Where there is an organized planning department it is frequently the case that the balance of stores records or perpetual inventory receipts of stores are kept in the planning department office, the receipt and withdrawal slips from the store room being delivered by hourly messenger service from the store room proper.

The actual store keeping organization, under such arrangements as have been above described, will consist of stores clerks, porters, and other employes engaged in transferring material from the receiving department to the store room, and in storing, disbursing, and delivering materials. Where there are several or many of these employes they will come under the supervision of an employe who may be designated as Chief Store Keeper with the rank in the organization equal to that of foreman.

36. Direction of Functional Activities.

Ordinarily, the purchasing department is an independent department, the head of which reports directly to the general manager. In some organizations where there is an assistant general manager in charge of operations or a works manager, the head of the purchasing department may be subsidiary to such official.

With regard to the remaining functions involved in a plan of control of materials and stores, namely, receiving, stores, planning, engineering, and correlation of statistics, there is a wide diversity of practices as to responsibility and accountability in connection with these functions.

A separate receiving department which has records of all outstanding purchase requisitions and which takes care of the physical receiving and recording in of all receipts, is customary except in the very smallest of industries.

An organized stores department which takes care of the physical storage and issuance of materials and collates the slips or tickets or original entry and maintains bin ticket records and continuous inventory checking, is also a well-established institution. We have come to realize that materials are money, only in different form, and that they need to be safeguarded just as cash is accounted for.

Modern management also requires a planning system of some sort. The main point is to have some person in charge of material planning and the perpetual inventory system, whether he be in the planning department, the purchasing department or the stores department.

The engineering department usually provides the technical specifications covering materials to be purchased. The planning or production control department usually designates the department of first operation to which materials are to be delivered as well as the subsequent travel or movements of each lot after leaving its store room or place of storage.

37. Correlation of Data on Materials.

In the matter of correlation, a good many of the larger concerns designate some one person as material supervisor. They find this move desirable because as a rule in most industries there is a very striking and evident lack of co-operation and co-ordination between the purchasing department, the stock room, the planning department, and the engineering department. A competent man in charge of this function is almost always able to save heavy interest charges for materials that were previously stored for months at a time. He is frequently able to cut down idleness of equipment and men to an almost negligible factor. He is likely to develop a more enthusiastic spirit of co-operation because all of the departments involved see that there is some one person that makes it his business to see that material is received on time and in quantities as best serve the needs of the business. In some organizations this function of correlation of statistics and control is assigned to a leading member of the planning department. It is important that he have sufficient authority to get action in whatever department action is necessary.

As an example of what can be done by means of proper material control I might cite the example of a large rubber company. This company's purchase supplies aggregate $3,500,000 a month. They have been able to reduce their investment in supplies, parts, and raw materials from $16,000,000 to less than $4,000,000, so that they are practically turning over their stock of materials monthly, all the year around. Their stock comprises over 25,000 distinct items. Their purchasing policy is to make contracts for six-month periods calling for shipment every two weeks, each shipment to be billed and paid for separately.

38. Results Desired in Material Control.

These can be classified and listed as follows:

1. To make the best possible use, not only of materials purchased, but of capital invested in the business, plant, equipment, and the men employed.
2. To prevent hitches in supply, and breakdown in the flow of materials to finished goods which involve wastes due to lost time and idle machines.
3. To procure materials and store them in requisite quantity to supply every need of production or service.
4. To provide these supplies without creating an over-supply; in other words, to prevent "frozen inventories," to have always sufficient but never too much.
5. To prevent materials being converted into more of one kind and less of another than are required for quick turnover into receipts of money from sales, and to prevent losses of sales and holding up of production orders.
6. To secure flow of materials into the factory in volume required for production and without bringing into storage more than the minimum quantities required to fill current needs.
7. For assembled articles or groups all processed component parts must be manufactured in the volume required for economical manufacture on the one hand, and on the other hand, in such lots and ways as are consistent with uninterrupted assembly.
8. If customers' orders are to be filled from stock, as is the practice in the majority of businesses, fluctuations in the demand for finished goods

should at once re-act on the store rooms where the potential goods are stored, and then through the store rooms to the purchasing department.

9. Establish the most effective and appropriate classification and placement of raw, semi-finished, finished, standard, special, inactive, and obsolete material, as well as material to be scrapped or salvaged.

VII. PLANS OF OPERATIONS AND ROUTING

39. Determining Operations.

We designate by the term "Routing" the determining of the most advantageous path of travel, department to department, machine to machine, and operation to operation, in converting raw materials into finished product. In the unorganized shop this flow of work is usually haphazard, and on the spur of the moment, the result being that parts are often misplaced or sidetracked. Under these conditions, machines and men on other work are stopped and transferred to rush orders for the replacement of missing parts. The result is, naturally, unnecessarily high production costs.

In an assembled product the routing will involve:

(a) The individual parts.
(b) The sub-assembling and general assembling processes.

The man in charge of this work will naturally be a member of the planning or production department. He will be supplied with the engineering data, blueprints, specifications and bills of material. He will have at hand for reference, the floor and equipment plans of the various departments showing the layout of the machines and production centers. He will also have available, lists or card indexes of equipment arranged by classes of equipment and machinery which will enable him to make assignments to specific machines and departments. He will naturally have to have easy access, also, to all of the data of the time-study and time-standards departments, as well as to the tool designing department. He is often the right-hand man or understudy of the methods engineer. With all of this information available he prepares a route sheet of operations covering each item on every order. Of course, where the item is to be taken from a stock of finished parts that is all which he will need to designate. As route sheets are built up the process will be for the most part drawing the route sheet from the files and checking it for any necessary changes.

40. Determining Most Advantageous Sequence of Operations.

The steps involved in routing are:

1. Determining from drawings. from finished parts, or assembled products, all the operations necessary to the performance of the work.
2. Determination of what would be the most advantageous sequence of operations.
3. Determination of the most appropriate machines on which the work is to be done.
4. The adaptation of each of the previous three steps to the kind and quantity of the particular equipment owned by the company, and the location of the same in the plant. These last considerations may necessitate a radical departure from what would be the ideal routing according to the first three steps.

It is customary to prepare a Process Chart for every order involving a variety of components. This chart is laid out so as to show what groups must be completed before general assembly takes place. The chart is laid out also so as to show what pieces must be completed before any single assembly group can be put together.

The person preparing such Process Charts must be familiar with the shop equipment. He usually has on file photostats or blueprints showing location and nature of equipment on each floor and for each department of every building.

The route sheet for each individual part is next provided. Preparation of route sheets affords opportunity for the arrangement of operations in logical order. It is obvious that the subsequent scheduling will be dependent on the routes laid down in the route sheets.

41. Determining Most Appropriate Machines.

It is desirable in preparing route sheets to designate not only the standard or most appropriate machine or production center for performing an operation, but to list also any possible alternates, or substitutes as second or third choice. The reason for this is that when the balance of work ahead records at any given machine shows a congestion at that machine, the recourse is to use the alternate or second choice. As a final recourse in emergency, the route sheet may list the name of some concern to whom the operation may be farmed out. This is often done in such operations as cutting of gears or in screw machine products.

42. *Adaptation to Kind and Quantity of Equipment and Its Location.*

Routing indicates where, how, by whom and in what standard time work shall be done. The logical head of routing work is a methods engineer who has had experience as a time study man. The selection of machines and tools to do the work is one of the most important duties of this department. The two most important accomplishments in the way of economy that can be performed by routing are:

(a) The separation of the operations in such a manner as to have only those operations which require skill performed by skilled labor and to have those operations which do not require skill performed by the class of labor capable of performing these operations.

(b) The selection of that type of machine and tool that will perform the work in a satisfactory manner at the lowest cost, taking into account not only labor charges but all other items of investment and operation charges.

The selection of the machine to do the work on any given lot will be influenced by such considerations as the comparative cost of setting up for the work. In many instances for small lots a general purpose machine may be found preferable to a special purpose machine. The selection is further influenced by the degree of congestion as indicated by the records of balance of work ahead at the various machines, a record which is usually kept in the scheduling department. Another factor constantly entering into consideration is the changes that are taking place from time to time in the design of newer machines and the use of newer methods of cutting metal, of removing metal by burning, and of joining metal by welding.

43. *Use of Material Handling Devices.*

Closely related to the problems of routing and departmental arrangement is the matter of selection of such equipment as belt conveyors, roller conveyors, motor driven factory trucks, chutes, cranes, hoists, and overhead trolleys, and all other material handling devices. In order to get the greatest benefit from some of these devices it may become necessary to materially alter a layout made without consideration of such devices.

The selection of material handling devices is frequently as important as and often even more important than the selection of processing machinery. The objects are:

(a) To reduce the labor, time and cost by substituting mechanical for physical effort.
(b) To increase output by delivering material to production centers and removing it in such a manner as to keep the facilities both human and mechanical in most continuous activity.
(c) To keep the material moving without delays from operation to operation and from department to department. This will help keep down the inventory through the elimination of large quantities of material ordinarily piled up between operations.
(d) To be sure that the returns on the investment are such as will insure greater profits.
(e) To help make scheduling automatic.

It is evident that discrimination must be exercised in the selection of material handling devices so as to be sure that they are adapted to the given conditions. It is important also that the costs of moving materials and the shop transportation problem in general be analyzed so that existing transportation costs can be compared with prospective ones involving the use of new material handling devices.

44. Kind and Number of Machines, Benches and Work Areas and Classes of Employes Needed to Carry Out the Program.

In order to have as few upheavals as possible it is desirable to analyze the equipment and material handling situation in comparison with the forecast of the annual manufacturing program and to plan the installations to be made at such time as the forecasts indicate will be the season of lowest production load. In this manner there will be the least interference with production. This analysis of future requirements will make it possible also to provide the employment department with forecasts as to periods when extra help will be required and when help may have to be laid off. It will also afford the purchasing department time to negotiate for the proposed new equipment.

45. Effect of Routing on Departmental Layout and General Location of Departments with Reference to Each Other.

Existing layouts of floors and departments are usually prepared by pinning small paper templets drawn to scale to represent the various pieces of equipment and benches on a sheet covering the floor or department in question. Photostatic copies are made of these layouts. When a new layout is proposed the envelope containing existing templets is taken from the file and new templets are made for the proposed new equipment. The old photostatic copy is corrected by the proper use of black or brown and white ink. The new templets are attached with pins or thumbtacks and we are ready to photostat the proposed or accepted new layout.

In determining how much space should be allowed between machines for passage ways, the first step is to have full information as to weight and space of work to be stored near the machine, the length of time it will be in the machine, and how much and for how great a length of time it is required to remain next to the machine, and for how long a time it is required to remain there after the operation has been done. Here again we must take into consideration what means are used in the particular department involved for handling material. Finally, we must allow sufficient room for the operator to move freely around with work, and also to give him easy access to the stock of parts to be worked on and the stock of completed parts which will have to be adjacent to his machine after he has completed his part of the work.

It will sometimes happen that the installation of new equipment or the manufacture of new products may involve departmental re-arrangement as well as internal re-arrangement within departments. Departmental re-arrangement is taken care of in a manner similar to that followed in locating a new machine. Paper templets drawn to scale are cut out representing the various departments. These are shifted until an arrangement is secured satisfactory to all involved.

VIII. SCHEDULING

46. Translating Plans into Work Assignments.

The term "scheduling" as used in industrial management in its most generally accepted interpretation signifies the listing of things to be started at a certain time and to be finished at a certain time.

As soon as the scheduling department receives the completed plans of materials and plans of operation for any given order, the next step is to see how this order lines up with the existing programs and schedules. The first check-up is to investigate with regard to each component the amount of that component called for by the year's and quarter's program, the amount as shown by balance of stores records as being on hand in finished stores and the amount on order in the shop.

These data are ordinarily kept as part of the balance of stores records. These stores records if they are not under the jurisdiction of the planning division of which the scheduling work is usually a department, are best maintained in a location easy of access to the scheduling department employes, and bound or filed in such a manner as to avoid delays on the part of either stores entry clerks or schedulers while one is waiting for the other. Filing or binding units constructed so that more than one person can work on the set at one time are therefore to be commended for the balance of stores records.

The number of pieces in stock and in process together with previously established schedules for the given component are used by the scheduling department as an aid in determining the time at which the new order if any is to be started. The final determination of the time elements will be explained hereafter.

47. *Inserting the Time Estimates.*

Where the routing has been previously established and time study data and standard times are recorded these are on the route sheets. If they are not established the route sheet as sent to the scheduling department will bear the pencil notation of "No record" or simply the letters "N. R." This notation serves as a signal to the scheduling department to notify the time study department who will determine whether the situation demands a time study or whether an estimate will suffice. If an estimate is used that fact should be indicated by the insertion of "est." before or after the time inserted.

48. *Establishing Work Quotas "Burdens" and Balance of Work at Each Machine and Production Center.*

For purposes of central scheduling it is necessary that a balance of work card or sheet be carried for each machine or production center and for each group engaged in sub-assembly and in final assembly work. These balance of work records are quite analogous to the material inventory sheets already described. They show work assigned and time estimates for each assignment. As work is completed copies of completed job slips are sent to the schedule clerk or scheduling department, who make deductions of these orders or jobs completed and show the balance of work ahead expressed in hours on each card or sheet covering every machine or production center. With such data available it becomes entirely practical to indicate at what time work is to begin on certain orders and certain operations, and at what time the work is scheduled to be completed. These balance of work records are also guides to the works manager and superintendent for the manning and equipping of the shop.

These balance of work records are sometimes designated as "Machine Burden" records although they should cover production centers which may not involve machines. Where a machine or group of machines in involved and the sum total of assignments indicates overburdening at any center it is a signal that consideration must be given to alternate equipment or the addition of new equipment or farming out of work if that is possible.

49. Determining When Work Is to Be Started and When It Will Likely Be Finished.

In determining dates for the starting and completion of assembling work the graphical method is very convenient. Cross section paper is used. Beginning at the extreme right-hand of the sheet of cross section paper and letting the small squares represent to scale a certain number of hours, we take the operations in reverse order, namely, the last one first, setting them off to the left, to scale, using a separate line for each component part. Where several parts are dependent on one another they may be put on the same line or bracketed into groups connected by a vertical line representing the final group assembly line.

It will be obvious from a construction of such a graphical chart, that the time at which work must be begun on the order is the total number of hours' distance of that item which is most remote from the final completion line. It is customary in these estimates to use a safety factor—commonly 20%—to cover delays, rejections, and spoilages. It is obvious also, that where there are a certain number of operations performed in different departments, it is unusual that a piece can be started, say on operation 5, immediately after operation 4 has been completed. It is customary practice to allow from one-half a day to a day, between the finishing of a lot in one department and the starting of the lot on the next operation where the pieces have to pass from one department to another.

This does not mean that there is a half day's or a day's work by truckers or clerks, being put in on each lot of pieces between departments, but it means that the lots are likely, after being completed in one department and before being started in another department, to have to take their turn in being moved from one department to another and in being started in the next department. The scheduling department and schedule clerk are sometimes designated by the name "order of work department" and "order of work clerk."

50. Preparation of Job Slips.

It will be recalled that we recommended that all slips for material withdrawals be written out in advance in the planning department. The reason for this was that correct terminology could be used and that deductions for those parts allotted to orders could be entered on the balance of material sheets and the slips would be ready to send with the other order and production data to the department which was to perform the first operation.

For exactly similar reasons it is desirable to typewrite the job slips with the necessary carbon copies, describing the routing of each component, the time allowances, date at which work is to start, and date at which work is to be completed; also the kind or class of machine, or nature of production center at which each operation is to be done. The designation of the specific machine by number, and the name of the man to do the work, are left blank as these assignments are made by the dispatch clerk, or in some cases by the foremen acting in the capacity of dispatchers. The progress of the shop copy of the work ticket or job slip is recorded usually on a Gantt type of chart, a check mark being made or a line drawn each time registry of a time clock stamp on a work ticket is made at the desk of a production clerk or dispatcher, this being ordinarily the place at which work tickets are time-stamped and new ones issued.

The Gantt chart is not the only method employed to record balance of work ahead. A simple record card will suffice, drawn up in the following manner:

WORK ASSIGNED TO MACHINE NOS.* ....

Work Assigned to Be Added			Balance Work Ahead in Hours	Work Completed to Be Deducted		
Order No.	Piece Symbol	Time Allowed		Order No.	Piece Symbol	Time Taken

* One card may cover a number of similar machines the local assignment being up to the local dispatcher.

IX. DISPATCHING

51. Dispatch the Action Element in Control.

Dispatching is seeing that the work is done in accordance with schedules.

The disciplinary and supervisory authorities over workers are naturally the foremen and superintendents who constitute the line organization. They are expected, however, to conform to the scheduling and dispatching of the production control and planning division, whose head, generally designated as Production Manager or Production Engineer, reports to the General Works Manager to whom the General Superintendent, or chief line and supervisory official, also reports.

The dispatching department is usually responsible for seeing that—

(a) Material requisitions are sent to the storeroom in time to deliver material to point of first operation and to see that the material is delivered at the proper time, neither too early nor too late and to see that worked materials are delivered in accordance with routing and schedules.

(b) Work orders, route sheets, instruction cards and tool lists are sent to point of first operation and accompany the material as it progresses from operation to operation and from department to department and that tools and fixtures as called for are delivered at times needed.

(c) That work orders and job tickets in accordance with schedules are at proper operation points and filed or posted in proper sequence.

(d) That time entries as to starting and stopping work are correct. That any over-running of scheduled time or excess over pre-determined costs is noted and reported.

(e) That inspection is carried out as specified in routing of order.

(f) That reports of completed operations, inspection and movement of material are going properly to point of central control or operator of central or master control board and that the central control board is a correct interpreter of conditions as indicated by local dispatch boards.

52. Moving Materials in Accordance with Routing and Schedules.

The material moving department is an essential feature of any factory production control system. The man in charge of this department supervises the truckers and laborers actually engaged in moving material and keeps all the necessary records to maintain control. He will always be making investigations as to the most economical types of material moving and handling devices with a view to their selection and adaptation to the various conditions and situations involved. Central control and dispatching are not complete unless a time-stamped coupon or telautograph or automatic telephone record is used to indicate the movement of material from one operator to another or to inspection and from one department to the next. Sometimes this is taken care of by a material movement or follower tag with coupons like a railroad ticket. This is quite distinct from the route sheet. The route sheet usually gives the routing to departments or production center. The local dispatcher inserts on the material movement or follower coupon the symbol or number of the machine used for the operation. Sometimes the inspection and move coupon are combined in one coupon. Sometimes a separate inspection coupon is used. The coupons properly time-stamped at the proper dispatch center and after local dispatch brands have been adjusted, are put either into a mailbox or pneumatic tube for transmission to central control board.

Owing to recent emphasis on the development of shop maintenance systems it has happened that in some large plants which had been previously rather loosely run the material movement is under the supervision of a transportation department reporting to the maintenance division. If accurate production control is desired it is important to transfer the material moving activities to the jurisdiction of the dispatching function or to set up such organization and procedures as will establish authority of and responsibilit to the dispatching department, so far as all material moving activities are concerned.

53. Providing Work Orders, Route Sheets, Tool Lists, etc.

The local dispatch center is the repository for all orders and all papers accompanying them. The center of first operation is the first to receive these papers which are usually inserted into a large heavy envelope of ample proportions. As soon as worked material is ready for movements all these papers must also move promptly to next dispatch center. It is up to central dispatching to see that these movements of necessary papers between centers are promptly made. Sometimes the papers can be designed for transmissal by pneumatic tube. It is obvious that there must be a supervisor over dispatchers and dispatching center to see that there are no inefficiencies, negligences or errors.

54. Seeing that Work Is at Proper Operation at Proper Time.

The dispatch supervisor is the reporter of current and impending interferences. These will always occur because there will always be cases of defective material and workmanship and even with the best of maintenance divisions there will be occasional break-downs in machinery. Sometimes the dispatch supervisor is called by the old shop name of "production chaser" or "interference man." He must see that all defective materials and operations are taken care of by replacements. He provides a follow-up for delayed purchase items. He also follows up all tool shortages.

55. Seeing that Inspection Is Made in Accordance with Schedules.

One of the important follow-up functions of the dispatch supervisor is contact and co-operation with the inspection department and to sell that department on the importance of adhering rigidly to schedules.

56. Seeing that Proper Time and Cost Records and Check-ups are Made.

The dispatch supervisor will also look over the work tickets at the various dispatch centers to see that proper time stamps are made and that excessive times are reported and investigated. In long runs it frequently happens that losses can be promptly stopped at the source by such prompt action.

57. Mechanical Aids to Scheduling and Dispatching—Pneumatic Tubes, Telautograph, etc.

Reference has been made to the use of pneumatic tubes instead of messengers. In some instances conditions are such as to warrant the expense of such installation. Some businesses can also use to advantage the telautograph while in some others the automatic telephone method of transmitting numerals and symbols will be advantageous. The principal use of these devices is to keep up instant communication between local dispatch stations and the point of central control. In some instances such devices are used for communications by the operator to the dispatch station. Such devices are aids to but not substitutes for complete planning.

58. Local Dispatch Boards.

The term "dispatch board" is usually applied to a bulletin board located in each department on which are placed a series of trays or a series of hooks which are to hold a portion of the job slips representing current schedules. It is customary to display on the dispatch board only those job slips which have been definitely assigned to specific men or specific machines. The un-assigned stock of job slips are usually kept in card index boxes or drawers in the desk of the departmental dispatcher or foreman, until the condition of the work makes them eligible for position on the dispatch board. The trays or hooks are usually arranged in series of three for each machine or operator, the upper hook or tray representing work being worked on; the middle hook or tray—work assigned and located at the work place but not yet started; and the third hook or tray representing work assigned but not yet placed at the machine or work place.

As soon as a job is started, the time of starting as well as the check number of the operator are designated on the dispatch board copy of the slip, as well as on the dispatch clerk's carbon copy. Similarly, as soon as the operation is completed, the job slip and the dispatch clerk's copy are time-stamped. The operator is given his next job slip properly stamped. Then the workman's copy goes to the time and payroll department, while the dispatch clerk's copy goes to the central scheduling or control board office. Entries are made in the tracing and balance of work records showing the completion of the operation and the date and time of day on which it was completed.

59. Central Control Boards.

This consists of a large board on which slides of wood or sheet metal with cards inserted or attached representing by their length of time estimates of jobs, move along horizontal grooves. The board has vertical markings representing dates. The control board is simply a combined record of assigned schedules and progress as indicated by the dispatch boards. The control board consolidates and makes available for quick survey and check-up by the works manager, superintendent, and planning department, the status of all work in the shop as related to schedules. In some lines of work a control board would be an unnecessary superfluity. In other lines it is of exceedingly great value.

There are numerous instances where such a control board has been built and efforts made to use it without first installing all of the control methods heretofore described. Naturally it could not be worked since mechanical devices are only an aid to and never substitutes for brains.

Central control board operation and dispatching naturally fall under the jurisdiction of the scheduling department which in turn is a part of the central planning and control division.

X. SHIPPING AND RECEIVING

60. Joint Occupancy of Space.

The most desirable arrangements in plant layout provide two separate railway sidings and truck approaches, one for shipping and one for receiving, each of these departments being located separately. However, it is seldom that this most desirable layout exists, the result being that the most practicable apportionment of space to prevent interference must usually be made in an area jointly occupied by shipping and receiving. Under such conditions it is customary to designate appropriate sides of passage-ways for use of incoming material and outgoing shipments respectively. The office portion can be jointly occupied but loading and packing areas must be distinctly separate from receiving areas.

61. Functions Usually Under Separate Control.

The shipping department is naturally and almost universally, a service department under the supervision and direction of the traffic manager in an industrial concern. Routes and classification rates, tariffs, claims, express and parcel-post matters, selection of proper shipping containers, accounts and statistics relating to incoming and outgoing freight and express bills, are all activities about which there is usually no question as to their properly coming under the direction of the traffic manager.

The traffic department ordinarily receives its shipping schedules from the order department although packing and shipping can be and usually are handling in just the same manner as shop operations through the systems of the scheduling department of the planning and production control division. The shipping department should be furnished a copy of every order which it is expected to ship, with complete information necessary to get out and pack all items, indication being made as to what items are to be drawn from finished stock and delivered directly to shipping department, also as to which if any items are to come in from outside.

The receiving department may report to stores, or to purchasing, but its records must tie in with those of central planning and production control.

The receiving department reports are usually made on autographic registers in quadruplicate, one copy going to purchasing department, one to stores department, one to central scheduling and one being retained in the receiving department files. Proper insertion is made of date received, purchase order number, partial or complete delivery, place to which delivered, and such detailed information with regard to pattern numbers of castings, dimensions of bar stock, etc., as will clearly identify each item received so that proper entries can be made on stores and production records.

62. Where Production Control Ends and Traffic Department Control Begins.

The traffic department usually controls packing, crating, skidding and containers because of their relation to rates. It is also the duty of the traffic department to plan in advance the most economical route and to follow up by tracer. The traffic department quotes rates to sales and purchasing departments, advises of anticipated rate changes, audits transportation charges, prepares bills of lading and prevents demurrage charges. The head of the traffic department usually sits in at the weekly production conference so as to keep posted on any prospective completions and arrange for shipping.

63. Sending Orders to Shipping Department.

Mention has already been made that the order department sends a copy of all orders involving shipment to the shipping office. The scheduling department also sends notice to the shipping department just as soon as any order is ready for packing and shipping or for partial shipment if that procedure has been agreed on between the order and production departments.

The shipping department in turn sends a copy of all packing lists and shipping notices to the accounting department, to the order department and to the central scheduling department.

It will be seen, therefore, that the central scheduling department is in constant and instant touch with every action and movement in regard to every order. This enables it to keep a control board, if one is used, in such form that it portrays the status of every order. Or if Gantt charts are used these will show the same facts.

64. Adaptation of Control System to Type of Industry.

We have purposely described in detail all the steps necessary to secure centralized control in the most difficult type of industry—namely, one in which a variety of articles involving manufacture for stock, manufacture to order, and assembly, occur concurrently. By a process of adaptation and simplification the principles and methods involved are applicable to industries of the flow type or mass production.

Control is essential in these industries as they are peculiarly susceptible to the piling up of unnecessary inventories as well as of serious shortages in the absence of careful planning and control.

XI. CONTROL OF PERSONNEL AS RELATED TO PRODUCTION CONTROL

65. Functions of Director of Industrial Relations or Personnel Director.

Ordinarily, Personnel Work includes direction over Employment, Employe Training, and all Employe Service activities such as Safety, Working Conditions, Recreations, Cafeteria, and Industrial Relations.

Frederick W. Taylor gave as the objectives of scientific management, the bringing about of reduced costs coupled with higher wages. This was to be accomplished by:

(a) Getting all the essential facts required in conducting any undertaking.
(b) Organizing these facts and tying them up with basic management principles.
(c) Selecting the most appropriate person for each type of work.
(d) Bringing the codified science principles and facts of the undertaking in appropriate form to each class of employes.
(e) Developing each individual to the utmost he or she is capable of being developed.

It will be noted that Taylor recognized as vital to the realization of his objective the proper selection of the workers, and their appropriate training.

66. *The Educational and Training Functions as a Vehicle for Explaining Production Control.*

Co-operation is based primarily on understanding. We cannot expect co-operation in production control when employes, supervisors, foremen, and executives have only vague conceptions of what it's all about and how it is intended to be conducted.

Company educational work naturally falls into the following grouping:

(a) Training for apprentices and others who should receive the apprentice type of training.
(b) Training for supervisors and foremen.
(c) Training for managers, executives, and members of staff technical and control groups.
(d) College graduate training.
(e) Sales training.

A curriculum for each of these groups should be prepared. It is usually best to separate curriculum subjects or courses by content matter before laying out any educational program or schedule.

A listing of appropriate study courses will include:

(a) Standard courses of training in the fundamentals of Foremanship.
(b) Standard courses of training in the fundamentals of Industrial Management.

(c) Specially prepared courses of training in company products and processes.
(d) Specially prepared courses of training in company organization, control, procedures, and systems.

Courses under (a) and (b) have been conducted in many companies. They are usually carried on by furnishing each member reading and study material and assignments of problems and reports. These are generally accompanied by weekly or semi-monthly conference and discussion periods on company time. At these conference periods a group leader draws out as many members as possible to stimulate them to active thinking to bring about conviction as to validity of principles and ideas and to give such inspiration as he is capable of, since attitude and action are influenced by emotional and inspirational stimulation.

Generally, the program stops at the conclusion of a year of such conferences. Perhaps department managers are called in during the second year to give addresses or read papers about their work. At this stage of development, however, there is a wonderful opportunity for co-operation between a competent personnel division and a competent planning and production control division in preparing courses under (c) and (d) above, namely, distinct, separate, and specially prepared training in company products and processes and in company organization, control, procedures and systems—with texts adapted to each class—elementary for apprentices, intermediate for supervisors, and advanced for executives, staff, technical, and control men.

67. *How Such Training Wins Understanding and Co-operation.*

Years of experience have demonstrated that in the safety field, freedom from accidents and lost time can be brought about only through careful organization and constant and continued promotional and educational efforts with drive and discipline back of the movement.

We need just as much and just as thorough organization, promotion, drive, and discipline to back up educational and training programs. The results in a financial way and in the way of bettered morale are such as to warrant making as strong an effort as has been made in the safety field. It takes specialized education, experience, and skill to gather appropriate material, write, illustrate, and edit it, and present it in educational and interesting form.

This is a task worthy of the best talent available, including often the services of high-grade consulting engineers and educators and high-grade educational institutions with experience in this field.

68. How Such Training Is Best Prepared, Conducted, and Directed.

The first decision to be made is the determination of the number of conference and discussion periods, and the adaptation of the training material units to fit the schedule.

Next, we must prepare what is most essential for the type and class involved and present it in such manner as will prove interesting and stimulating. This may involve printed and illustrated texts for home study, reports and case situations or demonstrations and movies or movie-talkies for conference and discussion periods.

Finally, while the best of outside talent may be employed to design and perfect training programs, they should be executed by the company's own personnel even if such company personnel needs outside coaching. The members being trained must feel that it is "*our* training," "*our* product," and "*our* instructors," and that the business is an organized friendship in which no one is so class-conscious as to feel he is beyond taking his part and doing his share to promote that complete understanding which is the real basis of co-operation and success. That many employes are keenly interested in company products and company procedures is attested to by the fact that many of them acquire surreptitiously, catalogs, sales literature, sets of printed system forms, etc., and discuss them. Anyone who has taught in night schools and correspondence work will attest to the prevalence of this interest which is often and in fact, generally quite unknown to, and unsuspected by, the men's supervisors and employers.

It is this natural interest which needs to be encouraged and where it does not exist to be stimulated.

There is no better means for such stimulation than a carefully planned and well conducted series of employe training programs.

PART III

CASE STUDIES IN PRODUCTION CONTROL

III

PRODUCTION CONTROL—NECESSITY OF MANAGEMENT TODAY

By ALFRED KAUFFMANN
President, Link-Belt Company, Chicago

PRODUCTION control is something that folks talk about at considerable length in production circles these days. The trouble is, though, they do not do anything about it. At least too many do not go far enough to get anywhere near all the profit there is in it.

Every one for the last few years has seemed agreed that production control, which of course ties in closely with budgeting, is a much-needed means of obtaining a better correlation between production and sales, to the end that a faster rate of turnover may come about. Nobody disputes that every phase of present-day conditions indicates the need of production control to a more intensive degree than ever before.

But I repeat, having reached this decision, most manufacturing managers take no really adequate steps to put it into action. They cannot continue long, now, in this blissful state of inactivity. For several years back it has been evident to any logical thinker on industrial management that we were due for a tightening up of production control.

If I size up today's situation aright, within six months now the manufacturer who fails to exercise the utmost control on his production will find himself up against an unpleasant set of facts. He will have to get his production schedule smoothly geared to his sales results and control the two closely as a unit, or some one else—perhaps representatives of his bankers—will be doing it for him.

And in many instances it is not a case of our not knowing how to cope with the situation. Rather, the trouble is that, under conditions like these, we do not apply the remedies soon enough. If only we did, the maladies for which we seek relief would often be cured almost before they were contracted or at least checked before they had done any harm.

There is altogether too much lag between decision and action. When it comes to tailoring major managerial policies to fit new conditions, there is always a good deal of hoping against hope that things will get better and maybe this or that step will not have to be taken—when better judgment may dictate that it be done at once.

True, the size of the organization has something to do with the delay. But procrastination at the top of an organization, aided and abetted by that same same characteristic urge by subordinates, is ever present in the small plant as well as in the large. It takes very nearly a full year to get an idea into 100 per cent operation if that idea the least bit tends to upset things as they are—habits whose roots have had several years' growth.

And here is why I say that it takes almost 12 months to alter, in all its ramifications, the course of a major policy. Check the following and see if it has not a familiar ring:

Let us say business has been going along pretty well with all that this implies in the way of a plant activity well up toward a comfortable maximum. Then the signs begin to point toward flattening the curve or maybe even to a recession, profit margins begin to taper to a dangerously thin strip. Better judgment urges "do something about it—and begin doing it right away." However, from the managers of branch plants comes this plaint, "Can't we have another month? Perhaps next month's figures will show up better."

You know how it is with the records of a month's progress. The figures do not come along till toward the end of the second month. If these plant managers are clever enough and insistent enough, and the management lenient enough, starting the job may be postponed still another month. And when the management's foot has been put down decisively, it takes another three months to get the thing across to all concerned.

I find as I talk with other manufacturers about this whole subject that there exists an excessive haziness as to just what constitutes production control and just what it will accomplish. To me adequate production control does not have to find expression as an elaborate system. Rather, it is any method—the simpler, the better—of co-ordinating material supplies, equipment facilities, and labor resources so that they function together to the best advantage.

I would not condemn as inadequate production control that failed to provide at the start of a job every last piece of material that was ultimately to be needed on that job—if there was enough material on hand to start the job when everything else was ready.

And I would count as faulty, for example, any control that urged incoming material shipments by express only to find that it must wait for a machine to work it up.

The successful production control aims to obviate blind endeavor. It gives a thorough insight into all the conditions, after which it is relatively simple to meet them.

Such a program matches at numerous points the needs which are going to stand out the most prominently in the year just ahead. There is keener competition, for example, and all that this implies in the way of narrower margins, difficulty of selling at a price to yield a satisfactory net, and hence the accompanying need to turn faster.

This situation can only mean that we must hook up sales and production more closely than we have been accustomed to doing. There simply must be a better correlating of production schedules and sales accomplishments. And we ought surely to see to it that our expenses also are geared to our sales results. A program which leaves out these requirements falls short of providing adequate production control.

The working of the sales budget is a problem and a story all by itself, but it ought to be at least mentioned here that the sales budget can play a large part in keeping on the right track in conditions like those that now face us. If the sales budget is thoroughly prepared, it calls for a—and that is what any budget does—survey of the entire production problem, as well as the selling possibilities. Besides representing our hopes the budget is the key to business control. And so to production control, as it bears a very definite relation to our allowable operating expense.

It was not so many years ago, as I look back at it, when we did not have in our own business an adequate production control. But with eight years of budgeting experience behind us, we can approach the future with much greater assurance than we could if we erected a superstructure of production control upon a foundation only recently laid.

Our experience has been that there is also a very definite relation of our sales budget to the normal capacities of our plants, which in turn are based on output attainable in business as fairly uniformly distributed over the 12 months. But we have the same problems the other fellow has. There are holidays, sickness, accidents, unforeseen shut-downs, and at times in the business cycle, a difficulty in getting the right kind of labor.

To meet these undesirable but ever-present shortcomings, we do not even aim at 100 per cent capacity; we base our standard operating factors on an average output equal to 80 per cent. On this 80 per cent activity we have to make our profits. Each department in the business is expected to operate with this 80 per cent as normal. Thus we show a loss when business drops below that level and a gain when business rises above it. So it is that a comparison of shipments with normal capacity, expressed in percentage, shows clearly the effect of volume on profits—of sales accomplishment on profits.

Time was, not so many years ago, when the crying need heard all over the country was for quicker, cheaper ways of making a quality product. We, in common with most manufacturers, hammered on internal making problems till, by and large, they were solved. Now the pinch comes in keeping effectively in the harness these new agencies of production so that they team up with the rest of the business.

We in America have production problems pretty well "licked," but production control is in general still to be coped with.

I repeat that we now have available the mechanical means of turning out product at what a few years ago would have been thought an entirely marvelous rate, but we do not control it effectively.

Take the handling of materials, for example. We in the managerial end of things have not kept pace with the handling equipment which has been placed at our disposal. There is again evident that common weakness—lack of co-ordination.

We may move parts in process highly efficiently and then let them stand because they cannot get into the machine fast enough.

In other words, there has been a weakness in scheduling—one phase of production control. We are given to putting stuff into machines without a sufficiently clear-cut idea of whether we can cope with it efficiently after we get started. Good industrial management calls for co-ordinating activities so that one operation dovetails into its neighbor without confusion or loss of time.

Not the last important function of the type of production we need under present-day conditions is that of speeding up the rate of turnover in the plant. Obviously, every time you put a semifinished part in a barrel with a lot of others, move it to the next operation and take it out again, you not only consume that much more effort and time as compared with an Indian-file flow by modern conveyor methods, but also you need that many more pieces—that much more capital tied up. A piece waiting in a tote-box for its move to the next operation might better be well-nigh finished and sold.

With modern close control over production, there is little excuse for the big backlog we used to think we needed to keep the production fire burning. And undoubtedly if we honestly set ourselves to it, we can cut down still further the proportion of material in process to output. We must do it, and soon.

But most of this talk is practically wasted unless along with it is emphasized common sense in application.

Just one simple example is enough to make the point—I have seen in our own plant innumerable cases very much like it. A special order of 12 pieces of product is put into production and then the inspectors hold up 11 perfectly good pieces for a week waiting for a perfect twelfth to come through, while the customer needs the stuff badly. Ordinary common sense and judgment must be acquired all along the line in the manufacturing organization that is to keep its head above water in the months to come.

Everything cannot go by formula. That was the rock on which was split the Taylor System in its original form. The Taylor principles of scientific management are as fundamental as ever, but their application in modern management has been tempered by a much-needed application of common sense.

This draft on common sense and relinquishing of set formulas in factory management, it seems to me, is leading us into the highly desirable situation where different department heads are placed more on their own. In fact, I think we have much of profit to learn from department-store merchandising methods wherein the toilet-goods department, let us say, is allowed a certain floor space, is charged with its share of overhead, and is expected to make a go of it. If the head of that department wants to carry on a sale or some similar special activity, that is entirely up to him. Might we not well take a leaf from the note-books of the retail-store merchandising manager in allowing a similar latitude and holding to a similar responsibility our various production department heads?

If I am correct, then, we have available—if we take advantage of it—all the refinement in equipment that we need for the moment. We have special materials suited to our needs. But we do not co-ordinate and control them to the best advantage. And often where we do know how to exercise the proper control, we fail to do it quickly enough to keep pace with changing conditions.

Finally I am convinced that we are quite overlooking a factor which is right at hand in every plant—the co-operation of our workmen. The change has come about so gradually that we frequently overlook it, but the average workman today is vastly more aware than he used to be of what business is all about. We ought to take advantage of this to get his co-operation. It is there for the asking, and a little encouragement.

If we have a job which was taken at an unusually narrow margin of profit, it is not at all uncommon for us to call in all the foremen and subforemen who are to have anything to do with the job and explain the conditions. Then we can count on their every effort to hold costs to an irreducible minimum. They never fail us.

PRODUCTION MANAGEMENT—A PROFESSION

By ARTHUR VAN VLISSINGEN, JR.
Contributing Editor, Factory *and* Industrial Management

ASK the works manager of an automobile factory his occupation: "Making automobiles," he tells you. Ask the superintendent of a tannery: "Leather business," he answers.

It is the same way all through manufacturing. This alignment of the plant executive with the industry rather than with the function of production management has immeasurably delayed developing a real profession of production management.

When you put the emphasis on the differences between two men they will inevitably seem unlike, even though to the anthropologist they are just two specimens of the human race with the minor differences which distinguish any two members of a species. Emphasize the essential differences between these two men's jobs and they will almost surely agree that they have practically no problems in common, even though to the thoughtful student of production management it is apparent that their problems are almost identical, barring the peculiarities arising from the conditions surrounding the particular industries in which they are engaged.

Let two production executives sit down together to tell each other about their workaday difficulties and triumphs. However much they emphasize the differences, a side-line listener inevitably concludes that in the major respects their problems are similar. The principal variations between the two jobs arise out of the pecularities of process, product and trade conditions under which they work.

Last April, on the sunny terrace overlooking a Carolina golf course, the manufacturing head of an automobile plant and the operating superintendent of a cotton mill were talking shop. "Our business is different," might have been the battle-cry of that mental tilt. Each man was intent on proving that his business is essentially distinct from the other's in every respect.

On the surface this is unquestionably so. Automobiles and gray goods. Bales and castings. Turret lathes and looms.

Yet in the course of talk they discussed whether to make or buy power. The northern man was buying power above what he could make more economically as a by-product from process steam, forging-hammer steam and heating steam. The Carolinian was buying all his power and generating a lot of steam which he used live for heating and slashing. He wrote down the name of the consulting engineer who laid out the Detroit job—here was a point where they could profitably swap experiences.

The textile man mentioned some rack floor trucks he had devised, and itemized the savings. The automobile man sketched on the back of an envelope a type of rack his plant uses to handle parts to a sub-assembly line, and saw a similarity. Then he announced that he would have a look at the mill trucks before starting home; there was something about the design he thought he might adopt.

They came to labor questions. Why, asked the Detroiter, is it desirable to build mill villages? He declared that he had always wondered. The mill superintendent explained the local labor kinks, and countered by asking about automotive wage levels and payment plans such as gang bonus and gang piece rate. Then he took a few notes to keep company, in the margin of his golf score, with the power-plant consultant's address.

DIFFERENT INDUSTRIES—SIMILAR PROBLEMS

By the time the chill of sunset drove them inside to dress for dinner, they had talked over at least a dozen important problems which are much the same in a cotton mill and an automobile plant. They had found not so many points of equal importance in which the difference is marked. But their parting remarks ran about as follows:

"Making cotton-goods is certainly different from our business."

"Yes, sir!" agreed the mill man heartily. "Next time I come north I'm coming over to see your plant. It must be interesting and mighty different from a cotton mill!"

When two experienced, competent production executives can arrive at such fallacious conclusions after two hours of swapping usable ideas, is there not justification for asserting that some one should emulate Karl Marx by stimulating these men to class-consciousness?

Production management deserves to be considered a profession. It is a profession, for it requires a highly specialized training and involves mental rather than manual labor. Its activity is as distinct, for example, as that of a designing mechanical engineer.

Engineers in whatever line of work meet to discuss their problems under the auspices of their professional societies. They exchange experiences through the journals of their societies. They profit—and their companies profit—from these mental contacts. The contacts are possible because the engineers think of themselves as a distinct class of men with distinct problems—and organize accordingly.

Various movements in the production management field are looking to a like result. The Production Executives Division of the American Management Association, the Taylor Society, the Management Division of the American Society of Mechanical Engineers, and the Society of Industrial Engineers are the outstanding organizations that compare favorably with the engineering societies in vision and in bringing to the light those phases of production management which run through every factory.

FACTORY *and* INDUSTRIAL MANAGEMENT typifies the same purpose projected in magazine form. Every competent, sincere industrial engineer in consulting practice is actually a miniature idea-exchange, gaining new experiences and facts in each plant, bringing to bear on its probelms the sum of his previous knowledge.

Production management has a long way to go before it becomes a science. Many keen thinkers in this field maintain that it can never hope to attain the status of a science, since each problem as it arises involves so many variables that it is bound to be unlike any previous problem. It must, these men believe, always involve so much of individual discretion and "hunch" that it will remain an art or a profession rather than a science.

Its development as a profession has been comparatively slower than it should have been. As the co-operative groups studying production management, the consultants and the broad industry publications increase in their influence and in the number of production executives reached, the development will gather speed. The years since the War, indeed, have seen production management emerging faster than before from the rule-of-thumb status to what thoughtful students in the field believe is its rightful position.

Society as a whole, industry as a whole, each competently operated manufacturing unit in industry—all these will prosper as production management grows in stature and in precision. Each man engaged in production management will certainly make proportionate gains of the sort he and everyone else are seeking.

The development can, however, be measurably accelerated. If every individual connected with production management will take it as one of his own responsibilities to think in terms of production management as a profession, to think of himself primarily as a production manager instead of a shoe manufacturer, an instrument maker or a flour miller, then he will be doing a share toward increasing the progress of something which should and will eventually come whether or no.

A CREED FOR PRODUCTION MANAGEMENT

Each one of us must adopt, as his credo, "My business is *not* different." He must also lend his own experience to the interchange of plant management ideas, he must lend his influence and effort to the organizations which are building production management to a profession.

In this way he will inevitably place manufacturing on a firmer basis than ever it has been. He will increase the prosperity of his industry and of his own organization.

Thereby, too, he is bound to increase his own value and the price he receives for his own contribution to the whole.

WESTERN ELECTRIC PRODUCTION CONTROL

By C. G. STOLL

Vice President and General Manager of Manufacturing, Western Electric Company

THE subject of production control has been given a great deal of publicity during the last few years, and from a theoretical standpoint there remains little to be added that is new or unique. The text books and journals of scientific management have presented the theory of production control in minute detail, and for this reason, this article will be confined to a description of the generally accepted principles of production control as they are applied in the Manufacturing Department of the Western Electric Company.

The manufacturing organization, which will be described, operates a plant which employs approximately 30,000 people, occupies over 3,000,000 square feet of floor space and produces annually over $150,000,000 worth of manufactured product. All the well-known mechanical operations are employed in this manufacturing work, as well as those peculiar to the rolling of copper rod and drawing copper wire, and the manufacture of ceramic products, paints, varnishes, and japans required for special purposes. The product manufactured involves the production of some 13,000 kinds of apparatus, requiring over 110,000 different parts.

For the purpose of clarity, the various phases of production control have been segregated under eleven main headings which are: Organization, Plant Layout, Planning of Manufacture, Scheduling, Operating, Tracing, Inspecting, Counting, Investment, Costs, and Results.

The ground covered by the first two are self-explanatory. Under the third heading, "Planning of Manufacture," there will be described the method of estimating the cost of a proposed product, determining the manufacturing methods to be employed, and providing machinery and tools. The subject of "Scheduling" will cover the determination of the production program, placing the schedules and maintaining stocks. Under "Operating," the direct control of labor will be discussed, and under "Tracing," the following of production through the factory. "Inspecting" and "Counting" will outline the methods set up for the determination of quality and for the counting and crediting of completed work. Under "Investment" and "Costs," the methods provided for their control; and under

"Results" will be discussed the means whereby the management may visualize the entire process of production and measure the results obtained.

The organization in general is set up along functional lines, each major class of work being performed by a separate organization. This is illustrated by the organization chart shown in Figure 1. It will be seen that there are seven major organizations, the duties of each of which are outlined in a general way on the chart.

The functions of engineering for manufacture or as it is more commonly called, manufacturing planning, are as follows:

1. Estimate costs. An expected hourly output for each operation, and the hourly labor values are established.
2. Analyze the design and prepare manufacturing drawings. These drawings tell the factory in detail what is to be made and define the mechanical and electrical requirements.
3. Analyze the manufacturing process. The actual operations required to produce a part or piece of apparatus, and their proper sequence is determined.
5. Determine and provide the machines on which the manufacturing operations are to be performed.
6. Determine the kind and amount of raw material required and the form in which it shall be purchased.

In short, the "Engineer of Manufacture" organization devises and furnishes complete plans for all the operations of manufacture and provides the equipment required. It is the organization which carries the responsibility for keeping the works abreast of the developments in the art of manufacture.

The functions of the production branch are:

1. To receive and analyze the orders for product, and to determine the monthly requirements in terms of apparatus, component parts, and raw materials and to order, receive and stock the raw materials.
2. To determine the manufacturing intervals and issue work orders and schedules to the operating departments.
3. To follow the movement of the work in order to ascertain those jobs not progressing according to schedule.
4. To assist in removing any obstructions which may interfere with accomplishment.
5. To issue a weekly statement to all branches, listing jobs which are not progressing satisfactorily.
6. To count the product and give official credit for work performed.
7. To do all warehousing, trucking and transfer work.

The plan of manufacture and the equipment supplied by the "Engineer of Manufacture" is received by the "Technical Branch" of the works organization and by them applied to the factory. The "Technical Branch" also provides the factory with instructions for manufacture in the form of layouts which definitely specify each operation to be performed, the tools and machines to be used, the speed at which each machine shall be operated, the containers in which the parts are to be handled, the amount and kind of raw material to be used, and the departments to which the parts shall be routed for inspections and subsequent operations.

The "Technical Branch" establishes the piecework rates to be used, follows the manufacturing work through its early stages to determine whether the methods and equipment employed give the results expected and accepts the burden of overcoming difficulties that may be encountered in the operation of the plan. This organization also acts as the works landlord, operating the power plant and service systems, maintaining the grounds and buildings, and supervising the watch and fire protection service.

The "Industrial Relations Branch" handles the various personnel activities of the works, employment, physical examination facilities, hospital, restaurants, contacts with employee clubs and associations and application of pension and benefit plans.

The "Operating Branch" comprises all of the departments which are actually engaged in the operation of machines and handling of productive labor in manufacturing the product. From the outline of the functions and duties of the preceding branches, it will be seen that every facility is furnished to the operating department, i.e., manufacturing drawings, layouts instructing them how to proceed, machines, tools, orders, materials and labor. It is the operating job to efficiently co-ordinate and utilize the equipment, materials and labor.

The "Inspection Branch" is responsible for the quality of the product from the receipt of raw material through each process operation to the final inspection of the completed apparatus. The inspection operations are conducted by groups throughout the plant located adjacent to the operating department whose work they are inspecting.

The "Clerical Branch" is the comptroller of the works. It sets up the clerical system under which the works shall operate, prescribe routines, computes the payroll, pays the help and the bills for material and supplies. This organization also compiles the costs and reports showing results.

Each of the organizations just described is complete in itself, having its own superintendent and staff working, of course, in co-operation with the other branches.

PLANT LAYOUT

In the arrangement of plant equipment there are two common methods open to the manufacturer. The first, and probably the most extensively followed, is the segregation of machinery and equipment according to class of work. Under this scheme, one group or department performs drilling work only; another, punch press operations; another, milling, and so on. During the process of manufacture each part passes in proper sequence through these various groups, until it reaches a department engaged entirely in assembling the product of which the part is a component.

The second method is that of assigning to each group the equipment required for the complete manufacture of an assembled unit.

Which of these two arrangements is the more economical depends upon the type and variety of the products to be made and the size of the schedules. For quantity production the former method offers various advantages. Chief among these are: the high degree of flexibility in manufacturing capacity, maximum machine activity, and minimum duplication of equipment. Furthermore, in grouping machines by types a high degree of efficiency may be attained as a result of specializing the efforts of the operators, and by having all of one class of activity under the supervision of a group of skilled artisans. This arrangement tends to promote a higher development of each line of manufacture and minimizes the problem of training unskilled labor.

The disadvantages are: increased handling, necessity for process inspection between departments, and setting up a system for controlling production and co-ordinating the efforts of each group.

SECOND PLAN OF PLANT ARRANGEMENT

The second scheme of plant arrangement, which groups the equipment required for the complete manufacture of a product or a line of products within one department, is chiefly applicable to jobs which require the use of special equipment or to jobs of small quantity. Its advantages are: the ease of schedule control, and the elimination of inter-departmental difficulties by having the entire manufacturing process on each product under centralized supervision.

The chief disadvantages of this arrangement are: high investment in plant and the fact that labor and supervision do not usually rise to the high level of efficiency attained by the specialized group usually reflected in both cost and quality.

In general our work lends itself well to the specialized method and that is the type of organization through which the great majority of our products pass. There are, of course, some departures from the specialized arrangement in the case of products which require a large amount of special equipment or are manufactured in small quantity, and in the case of products which during the various stages of construction are very susceptible to damage in handling.

In carrying out this general scheme of plant layout, the specialized departments in our buildings of the multi-storied type are arranged so that the work progresses vertically. The raw material storerooms and heavy machine departments are on the ground floor, the lighter machine departments on the second and third floors, the finishing departments on the fourth floor, and the assembly work and part storerooms on the top floors. In the single-story buildings designed for special products, the progress of the work is, of course, in a lateral direction.

An accurate forecast of the manufacturing cost of a new article, before its manufacture is undertaken, is no doubt recognized as one of the fundamentals of modern industry and for this reason the accuracy of the cost estimate is of prime importance. The cost estimate should reveal whether the contemplated design is practical from a manufacturing standpoint, how the capacity of the existing plant will be affected, and how large an investment in new plant and equipment will be required. All of these are contributing factors in determining whether or not the new project will be profitable.

At one time, cost estimating was largely a matter of guess, comparison and simple arithmetic. However, as we gain in experience and knowledge from year to year, the task of predicting costs is becoming less one of estimating and more one of reference to stand-

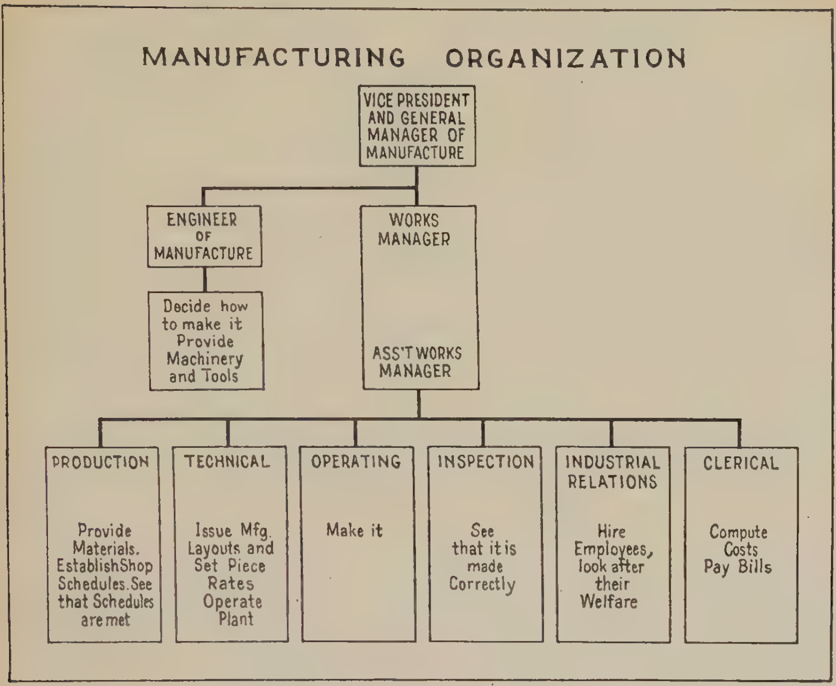

MANUFACTURING ORGANIZATION
VICE PRESIDENT AND GENERAL MANAGER OF MANUFACTURE
ENGINEER OF MANUFACTURE
Decide how to make it Provide Machinery and Tools
WORKS MANAGER
ASS'T WORKS MANAGER
PRODUCTION
Provide Materials. EstablishShop Schedules. See that Schedules are met
TECHNICAL
Issue Mfg. Layouts and Set Piece Rates Operate Plant
OPERATING
Make it
INSPECTION
See that it is made Correctly
INDUSTRIAL RELATIONS
Hire Employees, look after their Welfare
CLERICAL
Compute Costs Pay Bills

FIGURE 1. *Chart of manufacturing organization*

ard data compiled from previous observation and experience. As we continue to learn more of the capabilities of men and machines and make records of them it is possible to establish time standards in the form of curves and formulas, from which time values may be calculated with a high degree of accuracy. Estimating is consequently becoming more and more a matter of intelligent use of data already compiled in the form of standards.

DESIGN ANALYSIS AND PREPARATION OF DRAWINGS

The design of the new product has a very important bearing on production, and for this reason a thorough analysis of the design of each new article is made in advance of its actual manufacture. It is frequently possible by this means to eliminate features which would prove troublesome in the factory. Changes which will contribute to more economical manufacture or permit more rugged tool construction may be made, thus eliminating interruption to production by tool failure. Study of the design may disclose that it can be simplified, that it contains structural weaknesses or that modification will permit of greater tolerances. It may be practical to substitute a softer metal; increase the radii of bends on formed parts, so as to eliminate possible tool trouble; or change the size or shape of a hole to simplify tool construction and reduce maintenance. Such considerations have a very important bearing on the facility with which an article may be produced and on its cost.

After the final design has been approved the manufacturing drawings are prepared. These consist of detail drawings of each part, assembly drawings showing how the various parts are associated, a stock list showing the kinds and quantities of parts required, and a test sheet which shows the mechanical or electrical requirements which the apparatus must fulfill in order to assure satisfactory performance.

THE MANUFACTURING ANALYSIS

This analysis involves the determination of the logical and most economical sequence for the performance of the operations, and the selection of the best available methods for manufacture with special attention being given to the quantity of parts required and the accuracy with which they must be made. These factors have a very important bearing on the investment in tools and equipment, which in turn is reflected in cost.

When the quantities to be manufactured are large, a relatively heavy investment in equipment is justified to permit building multiple tools and combining operations, or even the construction of special machinery, in order to obtain higher outputs per unit of labor which, of course, should more than offset the heavy investment during a period well within the life of the equipment. When the quantities are small on the other hand, the cost of the more efficient types of tools is not usually warranted, and those of simple and inexpensive design must be used at a resulting higher labor cost. In each case, the procedure which will result into lowest total cost must be determined.

Accuracy is also an important consideration, as the productivity per man or machine hour is, in general, inversely proportional to restricted dimensional limits and tolerances. Excessive costs from this source are a reflection of the greater care that has had to be exercised; and the necessity for a high grade of labor and tools, and of high maintenance to tools and machines to keep them in condition to produce parts within the required accuracy.

The manufacturing analysis prescribes the sequence of operations, the tools and machines to be used, machine feeds and speeds, and the kind and quantities of material to be drawn from storerooms. This information when received by the "Technical Branch" is issued in the form of a manufacturing layout which serves the operating department as a complete instruction for the manufacture of the part.

At the time of preparing the manufacturing analysis, construction or purchase orders are originated for all the tools, machinery and equipment required to follow out the manufacturing methods which have been prescribed. These orders are forwarded to the Tool and Machine Design Department for design or editing and then to the tool shop for construction or to the buyer for purchase.

SCHEDULING—THE FORWARD PICTURE

In order to plan and execute a well-balanced production program some indication of the volume and character of future business is necessary. The first of the activities of the scheduling organization consists, therefore, of setting up a forward picture of the probable manufacturing activity. This forecast compiled semi-annually is based on the orders on hand, past requirements, and future indications and is expressed in terms of the major requirements, and future indications and is expressed in terms of the major lines of the product. These product requirements are later broken down into individual parts in order to present a picture of the probable future activities of the various manufacturing departments such as the machine and assembly department. The semi-annual estimate also provides a basis for a general survey of raw material needs and is used in compiling advance raw material requirements for use in contract or quantity buying.

While the semi-annual estimate does not authorize manufacture and is subject to some revision as time advances, it assists materially in the maintenance of an even shop load, and permits increases and decreases in the production program to be made most economically. It also enables each organization to get its house in order somewhat in advance of a change in actual production rate.

THE MANUFACTURING SCHEDULE

For a factory handling a volume and variety of apparatus such as ours, the task of scheduling the work so that the deliveries of the numerous individual orders will be accurately co-ordinated requires a close analysis of two fundamental considerations: the process time allowance and the distribution of load. For accurately estimating process time allowances, records are maintained showing the average time required for each part and piece of apparatus to travel through the factory. The more closely the allowance for each part checks with the actual performance the better is the scheduling organization enabled to plan an even distribution of the load. The economical operation of the factory depends very largely upon the accurate planning of this distribution, since it is only by the elimination of peaks and valleys in the production chart that labor turnover can be minimized, and the alternate idleness and over-crowding of machines and floor space avoided. Such conditions invariably increase manufacturing costs.

Our large variety of products presents perhaps every known type of scheduling problem. The demand varies from the year-to-year requirement of several million of one part to the special order for one of another part, which may never be made again. Between these two extremes may occur the large order which will not be repeated and the small order which will be fairly constant from year-to-year. The control of this problem requires a careful analysis of each order received, the maintenance of adequate process allowance records, and a definite "fitting" of each new order into the general production program.

MECHANICAL COMPILING

Definite authorizations for the manufacture of each major type of apparatus are issued monthly. As they are derived from a number of sources the summarization of all the monthly requirements on any one item would ordinarily present a complicated and expensive task. However, a mechanical tabulating system has been developed for which a card is originated each time the same item is encountered in our orders, and by mechanically sorting and combining these cards the total requirements can be readily compiled. In this way about 95 per cent of our preliminary summarizations which are necessary before proceeding with subsequent manufac-

Date Received	Month	Piece Part	Quantity	Deliver to Dept.	OPERATING CONDITIONS									HELD FOR							Date Promised	Date Completed	Dept.__________ Month__________ REMARKS
					Machine Capacity in Hours 42 832																		
					11032	978	580	1296	6123	604	12874	3171	190										
					Man Hours Available 46 700																		
					Type of Machine																		
					BENCH	#1½ BLISS	#3½ TOGGLE	#3½ #4 BLISS	#21½ #76 #5 BLISS	#6 FERRECUT	#75 #21 BLISS	#73½ #74½ BLISS	FOOT PRESS	Tools	R. M.	From Dept.	Mach. Repair	M. F. Parts	Help	Complaint			
7-2	7	87 527	150 000	6343	1400						700			c 16473									HELD FOR TOOL ON CHANGE ORDER W-745364
7-2	7	87 530	75 000	6352 6336	200 1600	120					140 840	120									9 *20		DAILY 4000
7-2	7	88 598	25000	6338				90			120 960										9-*22	9-21	COMPLETED
7-29	8	93 490	150000	6352 6336	905 2505	110 230					740 1700	300 420	116								9-*22		DAILY 5000
7-29	8	93491	310 000	6352				130 220		122	190 1890										10-2		
7-29	8	94 594	75 000	6332	400 2905						1010 2900										9-*21		DAILY 5000

FIGURE 2. *Operating conditions report kept by each operating department*

turing steps are handled with a speed and accuracy, which of course would not be possible by hand.

As each item of apparatus is assembled from a number of component parts, which may be common to other types of apparatus, the summarization of the component part requirements is also a somewhat involved problem. Here again the mechanical tabulating system may be used to even better advantage than in the preliminary summary.

For all standard apparatus items, several sets of tabulating cards showing the requirements of component parts are maintained, each set for a different quantity of the item, so that by combining these sets the total requirements of the component parts can be compiled without the additional work of issuing new cards.

From the part requirements thus tabulated, summarized schedules are prepared for the factory. The schedules are then analyzed for the raw material requirements. This information, obtained from the manufacturing layout, is posted to a master raw material record, which collects, for one kind of material, the requirements derived from the schedules of a number of different parts.

GENERAL PRODUCTION PROGRAM

The general production program which now represents the analysis of the sum total of all orders on hand, is distributed into monthly loads, and a card originated for each major piece of apparatus showing the required rate of production. In general it is possible at this time to fit each new job into the general program, and to determine when final delivery can be made, since standard intervals for each manufacturing operation have been previously set up from the process allowance records.

In the factory the schedules are supplemented by what is known as an "Operating Conditions" report, which is maintained by each operating department. One of these is shown in Figure 2. The quantity of each part required for the month is converted into machine and man hours from pre-established data, and the figures entered in their proper columns according to the type of equipment used. It will be seen that in a few of the columns more than one machine is listed, which signifies that the work may be performed on any one of these machines without affecting the cost. The cumulative total in any one column, when balanced with the total machine capacity for the type of machine involved and entered at the top of the sheet, readily shows any condition of overload or underload. By means of this sheet the foreman can readily determine the exact status of all jobs in the department, and is forewarned of the necessity for emergency measures. He is thereby enabled to control efficiently his activity and concentrate his equipment and personnel where required.

MAINTAINING STOCKS OF MATERIAL AND PARTS

After the receipt of the definite apparatus authorization, considerable time must elapse for procuring raw material, the manufacture of the parts, and the assembly of the parts into the apparatus. To eliminate this interval, sufficient stocks are maintained of all standard apparatus, parts and raw material to meet the current monthly requirements and to supply any moderate additional needs which may develop.

The stocking of materials, parts, and finished products is conducted by a number of storerooms, each carrying a distinct class of articles, and located in close proximity to the source of demand for those articles. For instance, one of the raw material storerooms carries all steel used in the form of bars, rods and sheets, and since such materials are heavy, this storeroom is located as near as possible to both the receiving platform and the departments using this material.

In general, current requirements can be filled immediately from current stocks and the monthly orders are to replenish this stock against anticipated requirements for the succeeding month. In maintaining stocks of apparatus and parts, it is of course necessary to again consider the required process intervals. The control of raw material stocks is affected by the value and nature of the material, the conditions under which it may be procured from normal sources of supply, and the general purchasing policy in regard to the particular item.

Although the ordering and stock maintenance of apparatus, parts, and raw material involves the control of 100,000 separate items, these functions are controlled with a relatively small personnel, by reducing the necessary clerical operations to a simplified form and establishing routines, formulas and methods which will, as much as possible, function automatically.

Complete records on all items of stock are kept in a master file where they are readily accessible to the organizations interested. In addition to a complete description of the item and its accounting designation number and classification, master cards show past monthly and yearly consumption, definite monthly requirements (as received from tabulating card breakdowns) and anticipated monthly rates (as derived from the semi-annual estimate). Piece part cards and apparatus cards also contain ordering instructions such as the process interval to be allowed, stock limits to be maintained, shrinkage to be compensated for, the value of the item, and the minimum quantity which can be economically produced in one lot.

Raw material cards show necessary purchasing intervals and any other information affecting the procurement of the material. Posting of information to this card file is performed by a carefully trained group of employees who are responsible for keeping the information up to date and for issuing all reports, balance sheets, and other information regarding the status of stocks. Master cards carry limits for overstock, ordering and understock, and where fluctuations in the stock balance carry the quantities on hand past any one of these points, the item is signaled by the posting clerk for the attention of the individual responsible. In this way the condition of "live" items can be followed very closely, while dormant items come up for survey periodically.

Wherever possible, computing quantities for stock replenishing orders is governed by a basic formula, this method allowing the delegation of the ordering to a less expensive clerical force than would otherwise be required. Such standardization enables us to control stock balances satisfactorily with a relatively small force of ordering clerks; one clerk, in some instances, controlling 500 to 1,000 separate items. While establishing more or less automatic controls does not always meet the requirements of unexpected demands, it is, in the main, satisfactory for our purpose. Overbalanced stock conditions, while they cannot always be prevented, can usually be minimized by a careful study of the situation encountered and the application of proper routines.

TRACING WORK-IN-PROCESS

In order to insure the delivery of parts and apparatus in accordance with schedule and to control investment we maintain a tracing system. This system is operated by an organization whose function it is to co-ordinate the work carried on by the various branches. Upon this organization also rests the responsibility for seeing that all necessary steps are taken to insure the successful carrying out of the production program.

The need of a tracing organization is brought about chiefly by manufacturing difficulties and potential sources of delay, which from their nature cannot be foreseen or guarded against without incurring a prohibitive investment in tools, machines, or material.

As previously explained, the orders placed in the factory are of two kinds: First, those which call for direct shipment, and second, those which are to replenish depleted stocks.

A copy of all orders and schedules placed in the factory and the required delivery dates on the parts and finished apparatus are furnished to the tracing organization. Knowing the quantity of each part required daily, it is the tracer's duty to watch the amounts of each available in stock, so that he may know on what to exert pressure.

In order to keep the tracing organization acquainted at all times with the movement of the parts and apparatus scheduled, a centralized set of records is maintained. These records show the quantities on schedule, the date and amount of each individual delivery from the various operating departments on the layout, and the total deliveries to date. This record is compiled from copies of the delivery tickets which accompany all material in its progress from department to department throughout the process of manufacture. The tickets are immediately forwarded to the tracing organization for recording on the piece part tracing record form. The schedule, in the upper portion of this form, is, of course, a requisite part of the records, and is filed with the tracing records.

This record presents an exact picture of the progress of the work, and from it can be readily determined whether the parts and apparatus are moving in accordance with the needs, and whether the Assembly Departments are receiving a continuous flow of parts in order to insure uninterrupted production of the finished product.

Due to unexpected demands, it is occasionally necessary to make deliveries earlier than originally scheduled, and in such cases the tracing organization assists the factory in rearranging its work with a minimum disturbance to other schedules. When such increases overtax the capacity of the operating department, it is the duty of the tracing department to analyze the problem and advise the foremen in what sequence the jobs should be produced.

The tracing organization is so organized that each group handles certain major classes of apparatus. This includes the manufacture of the component parts as well as the assembly of the apparatus. It follows that the personnel of each group, from their constant association in the factory with the apparatus to which they are assigned, learn to know what manufacturing difficulties or obstructions may be encountered. Anything that seems likely to endanger the successful accomplishment of the program is called to the attention of the organization functionally responsible. When occasion demands, it is also the function of the tracing organization to authorize emergency measures.

As an aid to the realization of the monthly rates of production on apparatus and parts, a report known as the "Trouble Bulletin" is issued weekly, in which those items not being produced at the required rates are emphasized. This report explains to the supervisors and executives interested the nature of the difficulties being encountered in maintaining productions, such as tool breakdowns, raw material shortages, etc. In this manner, the attention of the entire organization is directed to the apparatus or parts in trouble, or headed for trouble, which usually permits corrective measures to be taken before delivery promises have been broken.

PRODUCTION RECORDS: WHAT SPECIFICATIONS SHOULD THEY MEET?

An editorial answer to the question asked by 459 readers

PRODUCTION records. A good many plant executives doubt their value or resist their installation. Man, in surprisingly large numbers, puts up a strong resistance to change, on the principle that "It was good enough for father, so it's good enough for me." And change—constant improvement in processes and methods—is the one broad avenue leading to manufacturing progress.

When production records are installed, complexities of operation may stand as a barrier to their successful understanding and use. So one is not astonished to find a workman if not actually tallying upon the wall the pieces he handles, using methods little more modern. And yet the records of daily, weekly, or monthly production, properly maintained, might earn this workman's employer comfortable dividends where today he is getting gray hairs from worry because he is barely managing to keep out of the red.

Adequate production records, competently administered and used, are almost sure to increase the earnings of a plant. Production executives realize this more and more, are alert to cash in on that potential value. In a recent investigation, 459 out of 1,000 factory managers indicated that production records are of major interest to them, which places this subject first among all management problems. These production executives in manufacturing businesses, want to know how and where they can install production records to increase their profit showings, how the records they are already using can be improved to give better, more vital current operating facts.

Of what use, then, are production records? In the broadest sense, to reduce manufacturing costs and assure prompt deliveries. These results, of course, may be attained through any number of means: maintaining material and parts stocks at the ideal level; catching any production delays; placing under the management's finger any deviation, especially in the wrong direction, from acceptable manufacturing costs; any one of two dozen similar classifications of vital facts. And all of these must be caught at the earliest possible moment. Time is the essence of useful production records.

No general rule can be laid down for the exact time requirement of adequate production records for all plants. The permissible interval depends on the type of product and process, size of plant, mass production or job-shop work. In short, it depends on how often the management of the particular plant needs to see every detail of production to make sure that the plant will yield a satisfactory profit report to the stockholders.

What departments or types of department is it advisable to include when production records are installed? That also depends. But the picture is useful only if it is in perfect focus. The requirements of perfect focus include controlling regular and intermittent purchases of materials and supplies, controlling the course of the product through the plant—how long it takes from raw stock to shipping platform or stockroom, what it costs to produce no matter how many or varied the processes, how much material each unit takes. An essential is control of inventory. Too much raw material on hand may be as grievous an error of management as is too little.

And production records of the right sort co-ordinate volume of production with volume of sales.

Production records, intelligently selected and efficiently and simply administered, form the backbone of production that pays regular dividends. The experience of the plant executives is entirely in line with this statement. For a good system of comprehensive records is the basis upon which intelligent planning and budgeting rest.

A chief difficulty met in the use of production records, particularly in the very small plant, lies in the fact that workmen resent "paperwork," and are inclined to suspect anything resembling a careful and continuous check on their time. Some plant managers declare that the biggest job they have done was to educate foremen and workers alike to the practical utility of even the simplest paperwork control of labor and materials costs. Yet once the simplest forms are understood, and everyone sees the practical utility of the use of production records, the installation of more comprehensive methods is increasingly easy.

One fact needs keeping in mind, however. There is no panacea for production record ills. The form of production records and the uses to which they are put form a problem for individual solution. No two manufacturers make the same product, the same number of units daily, in the same working hours under the same working conditions. The records which will help the management at one plant may be only a nuisance if installed elsewhere. What records to use and how to use them are questions for every plant executive to answer for his individual plant. It will pay him always to remember that the simplest procedure commensurate with the results sought is the best procedure.

In this discussion of production records there are included the various mechanical devices. These are legion, but chief among them are: time recorders, particularly those giving elapsed time for the simple calculation of base pay and bonus payments; bookkeeping machines, especially those adapted to recording shop activities; adding machines; tabulating machines; and the rest. In a separate category are the numerous automatic machines that give the plant engineer a daily check on electric power, steam consumption, and so on.

Incidentally, let it be said that production records under the supervision of the plant engineer are among the most important to management. Besides giving an accurate up-to-the-minute picture of electric power and heating and process steam consumption, actual experience has shown that such operating records, taken for each machine, supply a basis for deciding in future purchases the advantage of one machine over another.

Selection of mechanical aids to adequate production record systems is an important part of the job. The right machine for the right task is quite as important in the factory office or the cost office as it is in a production department. The equipment and the forms used are interrelated; one influences the other. And selection of the proper mechanical means of keeping records is important because it has so great a bearing on holding down the expense of the records as well as getting the essential facts posted in minimum time.

To answer more specifically the question, "How often should one want a quick picture of all manufacturing conditions?" Two or three manufacturers find hourly checks necessary and important. One manufacturer writes that not only does he want a very quick picture of all production, but also he gets it on each producing unit each hour. This method he finds much more profitable than records showing production per day or per run. He concludes his observations on the utility of production records with the statement that, "while our records are made by production clerks, on an hourly basis, we are on the lookout for a mechanical, automatic system of recording that will be up-to-the-minute all day long."

A number of manufacturers find daily records sufficiently informatory, and others, in straight-line production with little variation in amount or kind of product, plan future operations upon weekly reports. The daily report, however, is perhaps the most generally used.

The form used by one manufacturer to report daily progress shows: number of units completed; total labor cost; labor cost per unit; total material cost; material cost per unit; overhead cost per unit, taken from an average of the previous month's production; and the total plant cost—material, labor and overhead—per unit. All of these costs are distributed through the various processes—unloading and inspection, cleaning, testing, welding, painting, loading and handling, plant construction and plant repairs.

The report also shows cash on hand in the banks and petty cash, sales invoiced each day with a total for the month, shipments both by truck and railroad and receipts by the same means of transportation.

This manufacturer, C. J. Colville of Newark Steel Drum Company, finds ample reason for the use of daily reports. He writes: "Suppose the cost of cleaning drums was greater per unit on August 16 than on August 17, although the production on August 16 was the greater. On checking this we might have found that although we used extra labor in that department to speed production, an hour or so was wasted due to a pump breakdown; or it may have been due to the fact that we were handling a particularly dirty lot of drums on that day.

"The figures on my desk each morning show at a glance whether everything went smoothly the day before. They give me the chance to check up immediately to find out if costs were as they should have been. It is astonishing to find that this daily check at times brings to light many small production difficulties that might have escaped our attention for some time, or perhaps might never have been noticed."

In distributing his costs through the various production processes, Mr. Colville is aided greatly by autographic time clocks. As workmen pass from one department to the other they punch in and out in each department so that an accurate and direct record is had of the time spent by each workman in each department.

For a weekly check on production operations, a single form supplied by J. L. Good, manager of the Eagle-Picher Lead Company plant at Hillsboro, Illinois, gives the quick picture in simple and complete form. This single sheet contains information both to control production and to give the front office an accurate view of proceedings. This company calls its report an operating report because it is used for dual control.

This single sheet shows the amount of raw ore used, purchased, its base price, the amount in transit and on hand and the total and normal stock. It also contains information on the amount of roasted ore produced, the anticipated production, consumption and shipments for the succeeding seven days, and all the needed manufacturing information on sulphuric acid and zinc oxide. Besides this there are also included on this report maintenance expense—both budgeted and actual amounts—in each manufacturing department, the number of employees by departments with a story of their movements, and departmental distribution of days without lost-time accidents.

These two forms are described here merely to indicate that whether a daily or weekly picture of all manufacturing is wanted, it can be secured on an 8½ by 11-inch form.

Though the benefits to be derived from the use of production records are many, obstacles to their use are also a matter for managerial concern. Expense of installation and operation, time required in securing and tabulating the desired information, difficulties incident to educating workers to their use, complexities of operation leading to the possibilities of hopeless involvement in unnecessary details—these are the principal obstacles. Also, manufacturers doing a jobbing business find their application difficult because of the wide range and sizes of products manufactured. The benefits derived from their use and how specific problems have been met are subjects of two articles in this issue. Other specific articles will follow from time to time.

There is a final word to say on the use of production record systems. They are well used, of course, to show how production is going, but the stress is not most profitably put there. *Getting* production is the thing to emphasize. And to do this, wide-awake management must put the right interpretation and right application on the data at hand. On this important phase G. I. McLaren, of Atwater Kent Manufacturing Company, Philadelphia, says:

"Undoubtedly there is some value in having a daily or hourly record of moves of material through the different operations, but the information is usually received after the move or lack of movement occurs and by persons more interested in collecting data than in preventing the numerous small errors that occur, causing tie-ups that need recording. Nor, in our opinion, do elaborate records prove their worth in preventing the recurrence of troubles. Seldom, if ever, do records give the complete cause of trouble, but rather the opinion or alibi of the person reporting it, and measures are taken to prevent its happening again without a direct investigation by someone of different viewpoint and experience, which rarely gives desired results.

"We have got the best results by keeping only necessary records of the flow of raw materials from outside sources, scheduling production through all departments and then supplementing the foremen with a staff organization of men with sufficient training and resourcefulness to avoid trouble by whatever means necessary, within the specifications of the job, and to see that production comes through as scheduled."

EQUALIZING PRODUCTION IN SPITE OF SEASONAL DEMAND

By GEORGE H. TOWNSEND
President, the Moto-Meter Gauge and Equipment Company, Inc.

THE production program in the Moto-Meter Company has been so arranged that a fairly uniform schedule of manufacturing is maintained, despite sales fluctuations caused by varying demand from consumers for instruments. In the very busy season as many as 10,000 instruments are shipped a day, whereas during the more slack period the number may be reduced to 5,000.

Stability of labor is also sought. This is a very vital matter because the making of Boyce Moto-Meters involves a certain skill that is developed only as labor is retained and turnover is kept at a minimum. Carrying a large inventory is less expensive than the costs entailed by frequent training of new workmen.

Under these circumstances, the general policy found most economical is to accumulate stock during the slow sales season and let it gradually be reduced as the greater demand develops during the busy season. Almost all manufacturing is done for stock. Uniformity in production schedules is also maintained by arranging all vacations for two weeks in August, which is the dull season, and shutting the plant down and taking the inventory at that time.

BUILDING THE PRODUCTION PROGRAM

The actual production program is determined by a foresight department which reports directly to the president of the company and is in contact with the purchasing and sales divisions of the business.

The initial step in laying out the program, therefore, consists in securing data from the sales division indicating the amount of business to be expected and analyzing records of past sales and orders on hand. Supplied with this information, the foresight department is in a position to calculate once a month just what kind of manufacturing schedule should be authorized. A study is also made of the stores records to find out the quantities of parts that are on hand, or on order, so that the purchase requisitions can be made out to replenish low stocks.

Having arranged to assure the receipt of all necessary materials, the foresight department makes out manufacturing orders to the factory for one month's production.

Parts comprising Moto-Meters are, to a large extent, small and of a miscellaneous character—castings, machine screws, etc. They can be much more cheaply bought in an unfinished state from outside concerns.

All incoming materials are received and stocked in a central storeroom in the basement of the factory. From this point they are sent, upon requisition, to the manufacturing departments. There are four other storerooms in the plant—two for finished parts from mechanical operations, one for finished glass parts, and one for name plates and scales.

The foresight department controls the work of production. Procedure is simplified by the policies adopted by the company to regulate its business operations. These have been previously outlined, namely, to reduce production costs through stabilizing employment and through keeping manufacturing schedules on as uniform a basis as possible. Skilled workers are required to maintain the high quality standards set for the shops, and if employees of this type were to be laid off in slack periods, they could not be re-hired in the season of sales peaks, because they would have taken other jobs. It is far more economical to produce on a practically uniform basis during the 12 months of the year, and to carry larger stocks of raw materials and finished instruments, than it is to peak production during the brisk sales period—March to September—and lay off half the force for the rest of the year when sales are down to half the volume. Transfers between jobs, when necessary, keep all skilled workers constantly employed.

The foresight department, therefore, bases its production program on reports from the sales distribution branches, received through the sales department, and forecasting probable demand for six months ahead. These reports are combined and schedules of production are laid out which will deliver the full quantity of each kind of instrument to the finished stockroom in ample time to meet sales requirements. Stocks already on hand and time required for processing are taken into account in laying out the schedules. These schedules are roughly planned for considerable periods ahead, and are reduced to the form of actual manufacturing orders covering a period one month in advance.

Manufacturing processes consist largely of machine work, the plating and enameling of metal parts, and the cutting, selecting and blowing of glass tubing and the fitting of discs, the rest of the work being assembling, testing, inspecting and packing. These operations on Moto-Meters are performed in four separate departments—enameling and plating, glass cutting and selecting, glass tube, and assembling. Distance type thermometers and self-regulating spark plugs are made in separate departments.

When the foresight department is ready to put a new lot of Moto-Meters into production, it ascertains, first, that the parts supplied by outside sources are on hand, ready for production, and that parts to be made or finished in the manufacturing divisions are on hand and ready to go through the processes necessary for them to enter the assembly of the instruments.

As it is essential at all times that the assembly department be assured of a free flow of material necessary for final production, the subsidiary manufacturing divisions follow the schedules of manufacture laid out for them by the foresight department.

As the foresight department is now ready to proceed with its manufacturing program, it issues an order to the enameling and plating department. Four copies are made, very similar to Figure 3, which is an assembling order. (1) The yellow copy is retained in the files of the foresight department, and is a record to that department that the order has been placed in process and that the raw materials are to be drawn from the raw material stock to complete the order. The other three copies, (2) pink, (3) yellow, and (4) green, go to the enameling and plating department.

The production foreman in charge of the enameling and plating department presents to the raw material stockroom yellow copy (3) and green copy (4). While all four copies of the order provide spaces for the insertion of data on the quantity to be manufactured, description, and desired completion date, as well as for the time that the order is actually completed, copies (3) yellow, and (4) green, record, in addition, the quantity of material to be issued on the order, the quantity of good parts completed, quantity of rejects, and the reason for the rejects, as well as the operators' numbers and length of time spent by each operator.

When the material is issued to be manufactured, the quantity is recorded on both yellow copy (3) and green copy (4). Yellow copy (3) is then returned to the production foreman with the material required. Green copy (4) of the order follows through with the manufacturing process to each of the three major sections of the department, namely, polishing and tapping, washing and plating, and enameling and sorting. The time spent on the order in each section is recorded on the order, together with the quantity transferred in turn to each of these three major sections, as well as the number of parts that are good, repaired, or rejected.

Green copy (4) is returned to the stockroom with the finished product. The information on green copy (4) is used to complete yellow copy (3), and the former is then returned to the foresight department to show the manufacturing result of the order, to complete the change in stock records necessitated by a raw material being manufactured into a finished part, and then to be used in computing costs.

Yellow copy (3) and pink copy (2) are then forwarded with the completed part to the finished parts storeroom, where yellow copy (3) is retained as a record of a completed part received, and pink copy (2) is forwarded to the foresight department as an acknowledgment of the receipt in the finished parts storeroom.

For the glass cutting and selecting department, which cuts glass tube into correct lengths, three copies of manufacturing orders are made.

The yellow copy is retained in the files of the foresight department until the order is completed. Two copies, one gray and one white, are then forwarded to the department. These are very similar, on both front and back, to the green copy of the order for the enameling and plating department. Spaces are provided to record dates, times, and quantities transferred to the various sections of the department.

The white copy is used as a requisition, authorizing the storekeeper to issue the required glass. On the back, columns and spaces are provided for a list of materials, and for amounts issued, returned, reclaimed and rejected. The material being issued, work then proceeds on the gray copy of the order, which, when completed, is returned to the storekeeper to have the information transcribed to the white copy. The gray copy is then retained by the storekeeper and the white copy returned to the foresight department for the necessary changes in the stock records and the computation of costs.

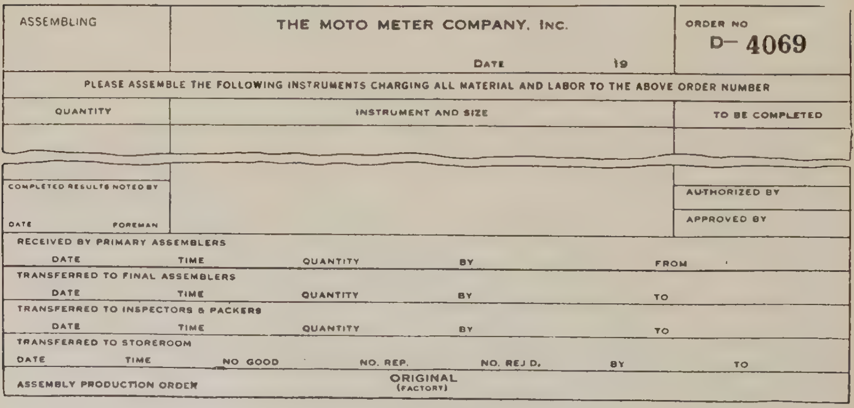
Manufacturing orders for the glass tube department are made out in triplicate, and are handled in the same way, except for notations of steps in processing, as are the orders for the glass cutting and selecting department.

A green copy is retained in the files of the foresight department, and a brown and a yellow copy are forwarded to the department, the yellow copy being used as the requisition for the material to be issued. The work proceeds on the brown copy, which is then returned to the storekeeper, the information transcribed to the yellow copy, and the yellow copy returned to the foresight department for adjustment of stores records and computation of costs.

When the finished parts storerooms have reported to the foresight department that the parts on an order have been received from the shops, the corresponding assembly order (Figure 3) is issued.

Three copies are made. The original (blue) closely resembles corresponding shop orders issued to other departments, except for the details of routing from section to section.

The second copy (pink) goes to the finished parts storeroom as a requisition for the parts to be assembled. On the back of this form a complete list of parts to be assembled, boxes in which to pack each instrument, instruction books and instruction tags to go into each individual box, etc., is printed. Columns alongside of this printed list provide for entry of specifications and data covering



ASSEMBLING

THE MOTO METER COMPANY, INC.

DATE 19

ORDER NO

D– 4069

PLEASE ASSEMBLE THE FOLLOWING INSTRUMENTS CHARGING ALL MATERIAL AND LABOR TO THE ABOVE ORDER NUMBER

QUANTITY	INSTRUMENT AND SIZE	TO BE COMPLETED

COMPLETED RESULTS NOTED BY

DATE FOREMAN

AUTHORIZED BY

APPROVED BY

RECEIVED BY PRIMARY ASSEMBLERS

DATE TIME QUANTITY BY FROM

TRANSFERRED TO FINAL ASSEMBLERS

DATE TIME QUANTITY BY TO

TRANSFERRED TO INSPECTORS & PACKERS

DATE TIME QUANTITY BY TO

TRANSFERRED TO STOREROOM

DATE TIME NO GOOD NO. REP. NO. REJ D. BY TO

ASSEMBLY PRODUCTION ORDER

ORIGINAL
(FACTORY)

FIGURE 3. *Assembly order*

type of instrument, issue, reclaim, reject, and short. A triplicate copy (white) remains in the foresight department.

Completed instruments in individual boxes are delivered to the storeroom. Upon receipt of orders from customers, requisitions are issued to be filled from finished stocks. The shipping department receives duplicate requisitions. In order to make sure that orders are correctly filled, the stockroom is not permitted to transmit its count to the shipping room. In fact, revolving carriers are placed between the two departments and instruments are placed in on one side and swung around to the other with only the order number attached. The carriers prevent communications and the shipping department must make and report a separate count before it is allowed to box the orders for shipment.

The company makes distance type thermometers for industrial use. These are processed and assembled in a special department upon orders issued by the foresight department. Some of these instruments are carried in stock while others are made on special order. A factory copy (white) of the manufacturing order goes to the shop. On the back are spaces for the record of work done on the order.

The duplicate copy (yellow) is retained in the foresight department as a record of the job.

Because of the various types of instruments manufactured, a number of requisition forms are used. A requisition covering the material required on an order calling for a particular style of instrument will be attached to such order in the foresight department. The triplicate copy of the order (pink), accompanies the white copy of the manufacturing order to the shop, where the white copy is retained and the pink copy, together with the special requisition showing the material issued, used, reclaimed or rejected, is returned to the foresight department for stores records adjustments and cost computations. The front is the same as that of other copies, while the back contains spaces for entering the material, labor and overhead expenses on the job to arrive at the total factory cost, and the unit cost.

A special department makes spark plugs. The original factory order (white) contains spaces for the usual data on the front. The back is blank. The duplicate (orange) carries, in addition, spaces for clerical data on the front, and on the back lists material required for the assembly of spark plugs. It contains part numbers, part names and spaces to record data—issued, good, refused, and junk. It forms the requisition for material from the storeroom. The triplicate (buff) is used as a record for the work-in-process file in the foresight department.

Time on jobs is kept in as simple a manner as possible. No time study has been instituted. Over a period of 10 or more years, during which operations have been gradually worked up to a high state of efficiency, the average correct output per employee has become established. Improved methods of processing and assembly have been introduced with good effect. For instance, multiple taps to replace single operations have increased output two- or three-fold. Nickel plating on conveyors has reduced the number of men required per group or gang, from a total of eight to only two. The conveyors together with the betterments they have introduced, have saved about 20 per cent on assembly costs, besides releasing floor space formerly occupied by trucks.

While steady increases in production per employee have been brought about and met by corresponding increases in wage rates over a like period, the control of quality is considered more important than a high production speed with lowered quality. In fact, workers are required to cover all Moto-Meters with cotton bags which go with them from operation to operation. Scratches on the instruments mean that they have to be done over, and the worker causing the damage to glass or highly polished metal is not paid for the labor on work he spoils. The owner of a Cadillac, Lincoln, Pierce-Arrow, Packard or Rolls-Royce car, and likewise the owner of a more moderately priced car, is very particular about its appearance and would not buy a Moto-Meter for his car unless it were finished as perfectly as the car itself. Customer demand explains why quality control is considered of greater importance than volume production if the latter should mean lower-grade workmanship.

The usual methods of pay are either piece-work or day-work. The former is used wherever possible, but the same weekly individual time card (of the in and out stamp-clock variety) is used for both, piece-work time record on one side, time-work record on the other. Hence, if a worker is switched to a different basis during the week, due to change of job, he has merely to stamp his in and out times on the reverse side.

Assembly work is done in groups and the speed of the conveyor regulates the speed of production. Output of parts is under the jurisdiction of the foremen.

Where it is necessary to keep detailed time and cost records on a job, a special card is employed, stamped by an electric time-clock. Spaces on this card provide for job number, clock record (start and stop), completed time, elapsed time, rate, cost, premium rate and points earned. These latter two entries are employed only in cases where some wage incentive plan is utilized, as is done on a few jobs.

Although the cost accounting work is to receive a special discussion, it is well to point out here that a system of standard costs is used. From long experience, records have been compiled showing just how much the unit cost on each instrument should be. At the end of each month the total costs on the total number of each kind of instrument produced, are known from the manufacturing order records turned back by the various departments. It is a quick process to calculate the individual unit costs on each type of instrument. If they vary in any case from the established standard, taking any changes in material, or labor rates, or overhead percentages into account, an investigation (guided by the symbol numbers on the production records) is at once possible for the location and correction of the trouble. If costs check closely with the standard, the expense of trying to cure the cause of minor discrepancies is money wasted.

STRAIGHTENING THE PRODUCTION CURVE WITH FLEXIBLE FORECASTS

By W. J. RHODES
Works Manager, The Carter's Ink Company, Cambridge, Massachusetts

ABOUT the best cure I know for the man who, in this age of distribution, implies that all the problems of production have been licked is to sit at a factory manager's desk while he is trying to figure out ahead of time how he is going to keep his plant *uniformly* busy throughout the coming year, always have enough finished goods to meet the needs of the sales department, and still no large excess to tie up capital needlessly.

No, not all the problems of production are completely solved. But we do know more about all the factors than we used to, and we think we use this knowledge more intelligently.

Take production control, to which I have referred. We think that here at Carter's we do a pretty good job of it, even though we admit at the same time that we can ill afford to sweep it majestically aside as "finished."

We have been many years developing our production control system; trying this little kink perhaps only to give it up a few months later, and then tackling that plan. That the development has been so gradual and over a long period would of itself tend to show that it is not a closed book. Nothing ever is in management.

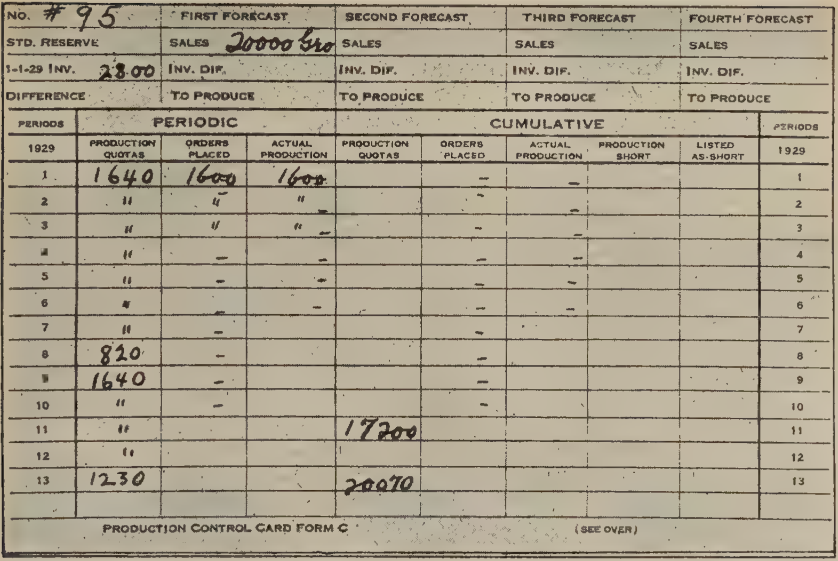
But out of all this cutting and trying has come a production-control system which in most instances accomplishes these three things: it furnishes enough goods at all times to avoid "shorts"; it prevents overstocking; and it necessitates a close watching of trends which seem to forecast increases and declines in demand.

At the outset, it should be explained that much of our product freezes in cold weather. This means that we must do the bulk of our shipping during the non-winter months. So when it comes to evening out production, this factor introduces a complication in addition to what might be called the normal seasonal demand for the goods. If a circle can be said to have a beginning and an end, our yearly cycle of production control starts in October, for it is then that we start gathering our *sales estimate* for the next year.

And at this time we also make a preliminary estimate of what the January 1 manufactured stock inventory is going to be. Incidentally this gives us an opportunity to build up threatened shortages and to get rid of a surplus. From these two sets of figures we arrive at our production estimate for the coming year. This work is completed in November.

Now I want to stop right here and bear down hard on one point. It should not be supposed for a minute that this estimate is a hard and fast figure which remains unchanged throughout the year. On the contrary we revise this estimate at the end of the fourth, seventh and ninth periods. And in explanation of this, I should say that we operate on a thirteen-period year instead of on a monthly basis.

In addition to this periodic revision, we have a monthly conference to make sure that things are going all right. In these conferences are included the sales forecaster, production manager, his assistant, manufactured stock foreman, and department floor foreman.



NO. #95	FIRST FORECAST	SECOND FORECAST	THIRD FORECAST	FOURTH FORECAST
STD. RESERVE	SALES 20000 Gro	SALES	SALES	SALES
1-1-29 INV. 28.00	INV. DIF.	INV. DIF.	INV. DIF.	INV. DIF.
DIFFERENCE	TO PRODUCE	TO PRODUCE	TO PRODUCE	TO PRODUCE

PERIODS	PERIODIC			CUMULATIVE					PERIODS
1929	PRODUCTION QUOTAS	ORDERS PLACED	ACTUAL PRODUCTION	PRODUCTION QUOTAS	ORDERS PLACED	ACTUAL PRODUCTION	PRODUCTION SHORT	LISTED AS-SHORT	1929
1	1640	1600	1600		-	-			1
2	"	"	" -		-	-			2
3	"	"	" -		-	-			3
4	"	-	-		-	-			4
5	"	-	-		-	-			5
6	"	-	-		-	-			6
7	"	-			-				7
8	820	-			-				8
9	1640	-			-				9
10	"	-			-				10
11	"			17200					11
12	"								12
13	1230			20070					13

PRODUCTION CONTROL CARD FORM C (SEE OVER)

FIGURE 4. *All the paper work on our production control centers in a card. The fact that even the card itself has often been changed emphasizes the point that our whole system is in a constant state of flux*

We try to make all of our large items of production at a uniform rate throughout the year. Obviously, with some of the small items it would not pay to put production orders through in small driblets. But the aggregate must run reasonably uniform as to rate of output.

At the present time the paper work on our production control centers itself in a 4 by 6 card. We have gone through all sorts of evolutionary changes in this respect. We have used charts of various kinds but have come back to this card as the best thing yet. Even the card itself has been changed from time to time. It is at present as reproduced on this page, but quite conceivably it will have some different appearance in another six months. I mention this because it serves to emphasize the point that our whole production-control system is in a continual state of flux.

In theory we plan to come up to the close of our shipping season, which is the end of our eleventh period, with no manufactured stock on hand. Actually we don't do it. We couldn't and be on the safe side.

Naturally, since we make our next year's forecast in October, we can't start at scratch. Rather, we have to start back of the starting line because there is still 15 per cent of the present year to go when we are planning for the following year. So we must subtract or add estimated inventory overplus or shortage at the end of the year. Furthermore, in making our reserve estimates we must remember that our eighth period is cut down so far as production is concerned, because of vacations, while the thirteenth is subnormal due to an annual shutdown for overhauling the plant and its equipment.

The whole process, in fact, is one of shaping the clay roughly in the beginning and doing the refined modeling and tooling as actual accomplishment dates draw nearer.

So much for the paper side of the planning. Now let us see when the materials-purchasing and production people start to take cognizance of the paper plan. When do they begin taking any action?

First, take materials. A perpetual inventory tells us at all times what is on hand. During a given period of the year, the inventory is scanned with a view to the requirements of the third succeeding period as indicated by the production forecast. Thus, for example, during the seventh period we order materials for the tenth period. And they must be in the plant and ready by the middle of the ninth period. This gives us a theoretical six-weeks' supply at all times.

In addition, we analyze the status of materials one period ahead to see if the stuff is on hand. If not, we do not release a manufacturing order to the plant, although we may give clearance to an order if the material is in transit. In this way we never have the old situation of an order in the plant, which cannot go ahead because of a shortage of materials.

In our plant the department foreman is really a department head. He carries out still greater refinements in our bit of forecasting sculpture, for he makes a ten-day plan every week. He, too, has a bit of leeway in his more limited planning just as we in the office have on the plan as a whole. For, by making his ten-day plans every week he has an overlapping of three days which gives him a chance to make corrections.

Underlying the whole thing there must be a consciousness on the part of the entire factory staff that it is its duty to give the sales department what it wants. It is the purpose of our production-control methods to get results on the basis of that sense of duty.

Nor is it a matter of fad or fancy that we have an established method of forecasting. We are simply forced into some system which will give us a foundation of reasonable security, due to the rapid changes that are occurring in business today.

SHAPING THE SEASONAL LINE TO QUANTITY PRODUCTION

By A. C. GILBERT
President, The A. C. Gilbert Company, New Haven, Connecticut

MANUFACTURING one particular kind or line of goods throughout the year is doubtless the most common, and certainly the most favorable, condition for quantity production. But when goods have a seasonal demand, the question arises: Is it more economical to run at a low rate of production steadily throughout the year, storing up surplus stock for the seasonal rush, or is it better to run on a quantity production basis for a part of the year and shut down for the remainder? Obviously, shutting down is to be avoided if in any way practicable. Even so, the answer is not entirely straightforward. Actually, it is something like this: Produce, if you can, a line of seasonal goods having different seasons, and for which the same machinery and equipment can be used. Then run on a production basis the year round.

This is very much what The A. C. Gilbert Company, of New Haven, Connecticut, has done. While there are relatively few firms making the company's product, toys, yet in the handling of seasonal goods the company's problem is typical of that met by manufacturers in many other lines.

The company began to make mechanical toys years ago. These toys include, in some of the sets, small electrical motors. Screws, plated and lacquered metal parts, rather elaborately decorated boxes, and printed instructions were all required and turned out in the plant with thoroughly modern equipment. But, of course, the great demand for toys of all kinds occurs at Christmas time. Something like 90 per cent of the year's total sales are made then. Consequently, the factory was busy for only a part of the year, with the result that most of the employees worked only about half the time. What that meant from the standpoint of efficiency and earnings, it is not necessary to enlarge upon here.

However, employment is now steady. The company has gradually developed, over a period of years, a line of small electrical goods, some of which have a seasonal demand and others a fairly steady year-round demand. The latter form the bread and butter. The line now includes toys for holiday selling, radiant heaters for winter, vacuum cleaners for spring and fall, fans and hair driers for summer. In addition, there are mixers, vibrators, fruit-juice extractors, electric whisk brooms, and drills, that find a market the whole year round.

This diversity of products is very satisfactory from the standpoint of continuous production. The items which are in demand substantially the year round are wide in variety and assure a definite amount of plant and organization activity. Efforts to develop and expand this part of the company's production are unrelaxing.

Toys, originally the sole product, and other products with seasonal demands then assume the role of specialties super-imposed on a steady production of other goods. These specialties have different seasons, so that when one falls off, another begins. The management, therefore, must see to it that the volume of each specialty is so balanced that substantially the same number of employees and machines is kept busy. Also, if any of the products either in the seasonal or continuous class fall off, special efforts must be made in some direction to make good the deficiency. With such a wide variety, this is not as difficult as it would be if the limits were narrower.

The same plant equipment is used for practically all the products —screw machines, tools, and dies, for instance. Winding machines for toy motors wind the small motors for all electrical appliances. This is also true of the polishing, grinding, plating, painting, and baking equipment. The box-making and printing departments which, of necessity, must be rather elaborate to make the containers and print the instructions for all of the company's products, are well adapted to care for the whole line. And, of course, the various products do not differ essentially from the receiving and shipping standpoint. When it comes to assembly, however, it is necessary to have separate departments.

Thus it will be seen that in effect all the equipment and all the workers are kept busy all the time. Naturally, as the company has grown, additional equipment has been added, but not nearly in proportion to the increased output. Continuous quantity production, then, with all its advantages, has been made possible.

CO-ORDINATION THROUGH BUDGET OPERATION

By HAROLD VINTON COES

Formerly Vice President and General Manager, Belden Manufacturing Company
Formerly Vice President, American Society of Mechanical Engineers

THE budget is a means for accomplishing certain very definite results in manufacturing provided the proper methods are adopted and followed. From an unusually successful experience in reducing costs and controlling operation, Mr. Coes writes of his tested and proved methods, which may be adopted by anyone as certain to bring equally worthwhile results. He testifies that budget procedure has enabled him to reduce operating expenses, factory burden, sales and administrative expenses, and maintenance expense; to regulate production with sales demand; to regulate and reduce inventories; to regulate bank loans; to control expenditure for capital account.

Practically all budgets are based on, and of necessity must be based on, the sales budget or quota. Sometimes, in some types of business, this volume cannot be stated in units, such as pounds, tons, feet, cases, dozens, gross, etc., as well as in dollars, but must be stated in dollars per class of product. This is because the individual sizes, styles, units, etc., in a given product classification may vary, and generally do vary, with respect to the other items in the group; again new items may be added and old items dropped, but whatever the nature of the business and its products, the sales quota is the starting point.

It is impossible in many more cases than it is possible, to make a sales or volume forecast for the year that is not subject to fluctuations, wholly or in part, beyond the control of the individual business. Therefore, when the yearly forecast is broken down by months, or any other period, in accordance with the particular business's experience as to its volume curve for the year, it is generally necessary to narrow the forecasting period down, as a practical matter, to a shorter period than the year; as low as a week in advance in some cases, and then to adjust the previously determined budget up or down, as the facts warrant.

R. H. Heberling of the Business Research Corporation, speaking before the American Management Association, recently remarked: "Seasonal sales mean valleys and peaks of distribution. In the slack season production will exceed sales. The reverse will hold true

TABLE 1

FUNDAMENTAL OPERATING RELATIONSHIPS

	1922	1923	1924	1925	1926	MAX. OR MIN.
	%	%	%	%	%	%
Ratio of the $\frac{\text{Cost of Sales}}{\text{Net Sales}}$	79.9	79.2	78.1	77.8	80.1	75
Ratio of $\frac{\text{Mfg. Expense (Burden)}}{\text{Net Production}}$	29.4	24.0	26.8	26.1	23.5	22
Ratio of $\frac{\text{Mfg. Expense}}{\text{Net Sales}}$	24.5	22.0	24.3	24.7	20.2	20
Ratio of $\frac{\text{Raw Material Inventory}}{\text{Net Production}}$	40.1	42.0	41.9	39.8	38.9	35
Ratio of $\frac{\text{Process Inventory}}{\text{Net Production}}$	30.1	32.0	31.0	29.9	29.2	26
Ratio of $\frac{\text{Direct Material}}{\text{Net Sales}}$	37.5	35.2	37.2	38.5	39.1	35
Ratio of $\frac{\text{Direct Labor}}{\text{Net Sales}}$	23.4	22.8	20.9	21.7	22.0	20
Ratio of $\frac{\text{Indirect Labor}}{\text{Direct Labor}}$	47.0	46.5	46.1	45.8	45.2	40
Ratio of $\frac{\text{Finished Goods Inventory}}{\text{Net Sales}}$	10.8	10.4	10.1	10.5	10.0	10
Ratio of $\frac{\text{Total Inventory}}{\text{Net Sales}}$	24.3	24.0	23.8	24.2	23.0	20
Ratio of $\frac{\text{Fixed Expense}}{\text{Total Mfg. Expense}}$	28.1	28.3	27.9	27.2	27.5	25
Ratio of $\frac{\text{Working Capital}}{\text{Net Sales}}$	35.1	34.8	35.5	34.2	33.1	30
Ratio of $\frac{\text{Gross Profit}}{\text{Net Sales}}$	21.1	20.9	21.9	22.2	19.9	25
Ratio of $\frac{\text{Selling Expenses}}{\text{Net Sales}}$	10.9	11.0	11.4	12.2	12.5	11
Ratio of $\frac{\text{Net Profit}}{\text{Net Sales}}$	4.3	4.7	5.1	5.5	3.9	5

when sales reach the peak. When market conditions are uncertain and variable it may be desirable to shorten the budget period to maintain reasonable accuracy in forecasting. In one company the peak of inventory came in the middle and late summer; the peak of collections was reached in the late winter months. With the budgeting period one year, by months, the collected revenue was forecast within a 5 per cent degree of accuracy by months, and 1 per cent error for the year. From the experience of different types of business it would appear that the budget period should be shortened when the hazard is great and lengthened as the business hazard decreases."

Before the budgets regulating inventories, production, expenses, etc., can be properly determined and adjusted to the fundamental budget, it is desirable to make certain studies to determine the fundamental relationships between properly related factors of the business. Blessed is the concern that has its essential facts and statistics so recorded or entered, and preserved, that the proper tabulation of the essential data can be readily determined, and trends and tendencies obtained graphically. Table 1 shows a number of these relationships.

In every business there will be found a proper relationship of these items if the various divisions of the business are in balance. If the inventories are out of balance, the actual ratio will be higher than the correct or budgeted one. If proper material-handling devices are not in use, then the indirect labor will bear an incorrect relationship to the direct labor, and the manufacturing expense will be higher than the business should stand. The gross profit will be lower and so will the net, as a rule. If collections are behind, the credit policy is bad, or sales terms faulty, then the working capital ratio will be out of line.

Therefore, it is essential that we first determine what the proper fundamental relationships are for the various items it is proposed to budget, for these are the initial points of control.

RELATIONSHIPS OF DATA

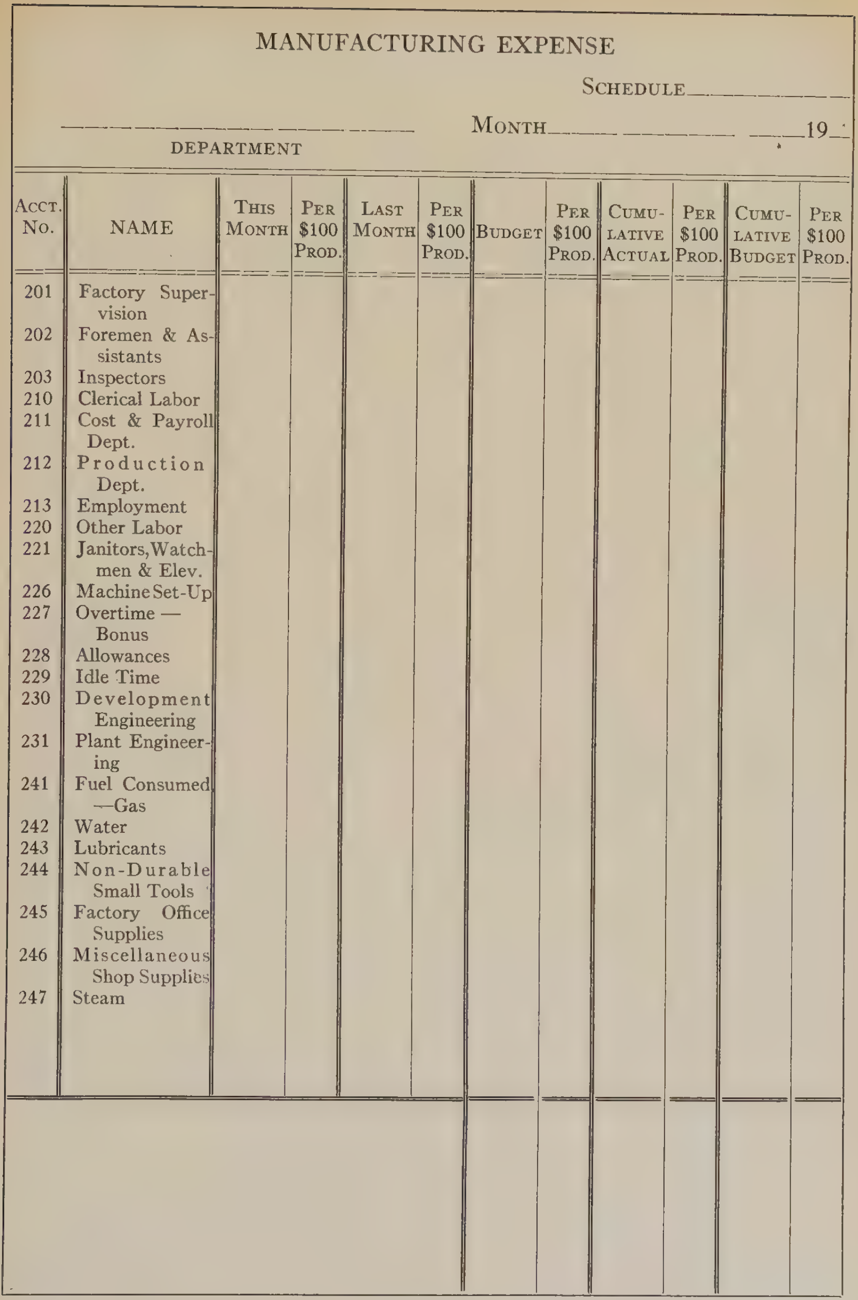
I have by no means enumerated all the relationships that exist or that can be properly utilized, but I have set forth a number of those that do exist in most manufacturing businesses. Needless to say,

Table 2

COMPARATIVE RESULTS OF OPERATIONS FOR DIFFERENT SALES VOLUMES

Sales (thousands of dollars)	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000
Sales (percentage)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Materials	40.3	39.4	38.5	37.8	37.2	36.7	36.7	36.7	36.7	36.7	36.7	36.4	36.1	35.8	35.5	35.2
Direct Labor	28.0	27.5	27.0	26.5	26.0	25.5	25.5	25.5	25.5	25.5	25.5	25.0	24.5	24.0	23.5	23.0
General Factory Expense	20.0	19.0	18.0	17.0	16.5	16.0	15.5	15.0	14.5	14.0	13.5	13.0	13.0	13.0	13.0	13.0
Cost of Sales	88.3	85.9	83.5	81.3	79.7	78.2	77.7	77.2	76.7	76.2	75.7	74.4	73.6	72.8	72.0	71.2
Gross Profit on Sales	11.7	14.1	16.5	18.7	20.3	21.8	22.3	22.8	23.3	23.8	24.3	25.6	26.4	27.2	28.0	28.8
Selling Expenses	8.0	7.7	7.5	7.3	7.1	7.0	6.9	6.8	6.7	6.6	6.5	6.4	6.3	6.2	6.1	6.0
Selling Profit	3.7	6.4	9.0	11.4	13.2	14.8	15.4	16.0	16.6	17.2	17.8	19.2	20.1	21.0	21.9	22.8
Administrative Expense	10.0	9.0	8.0	7.0	6.5	6.0	5.9	5.8	5.7	5.6	5.5	5.4	5.0	5.0	5.0	5.0
Operating Profit	6.3*	2.6*	1.0	4.4	6.7	8.8	9.5	10.2	10.9	11.6	12.3	13.8	15.1	16.0	16.9	17.8

*Loss



MANUFACTURING EXPENSE

SCHEDULE____________

____________________ MONTH_______________ ____19__

DEPARTMENT

ACCT. NO.	NAME	THIS MONTH	PER $100 PROD.	LAST MONTH	PER $100 PROD.	BUDGET	PER $100 PROD.	CUMULATIVE ACTUAL	PER $100 PROD.	CUMULATIVE BUDGET	PER $100 PROD.
201	Factory Supervision										
202	Foremen & Assistants										
203	Inspectors										
210	Clerical Labor										
211	Cost & Payroll Dept.										
212	Production Dept.										
213	Employment										
220	Other Labor										
221	Janitors, Watchmen & Elev.										
226	Machine Set-Up										
227	Overtime — Bonus										
228	Allowances										
229	Idle Time										
230	Development Engineering										
231	Plant Engineering										
241	Fuel Consumed —Gas										
242	Water										
243	Lubricants										
244	Non-Durable Small Tools										
245	Factory Office Supplies										
246	Miscellaneous Shop Supplies										
247	Steam										

FIGURE 5. *Form for manufacturing expense budget*

SCHEDULE____________

MANUFACTURING EXPENSE

________________________ ______ MONTH____________________19__

DEPARTMENT

ACCT. No.	NAME	THIS MONTH	PER $100 PROD.	LAST MONTH	PER $100 PROD.	BUDGET	PER $100 PROD.	CUMULATIVE ACUTAL	PER $100 PROD.	CUMULATIVE BUDGET	PER $100 PROD.
250	Unassignable Frt.-Exp.										
260	Employees' Service......										
270	Accident Compensation										
281	Defective Workmanship										
282	Defective Workmanship Cr.										
283	Other Losses Due to Errors										
291	Purchasing Dept.										
292	Stores—Rec. Department										
293	Finished Stock Department										
294	Shipping Dept.										
295	Labeling Dept.										
296	Rewind Dept.										
301	Rearrangement of Equip.										
303	Traveling Expenses										
305	Garage										
306	Shop Electric Plant										
307	Instruction of Apprentices										
308	Unassignable Testing Expense										
309	Other Mfg. Expense										
310	Spool Expense										
311	Foreign Spool Expense										
312	Laboratory										
313	Inter-Plant Expense										
314	Assn. Dues and Memberships										

FIGURE 6. *Form for manufacturing expense budget*

SCHEDULE__________

MANUFACTURING EXPENSE

______________ MONTH__________________19__
DEPARTMENT

ACCT. No.	NAME	THIS MONTH	PER $100 PROD.	LAST MONTH	PER $100 PROD.	BUDGET	PER $100 PROD.	CUMULATIVE ACTUAL	PER $100 PROD.	CUMULATIVE BUDGET	PER $100 PROD.
321	Insurance										
322	Taxes										
323	Rentals										
324	Depreciation										
330	Development										
340	Power Plant Oper. Labor										
350	Power Plant Supplies										
360	Power Plant Inc. Oper. Exp.										
370	Power Plant Maintenance										
390	Power, Heat & Light Purchased										
410	Maintenance Land										
420	Maintenance Buildings										
430	Maintenance Structures										
440	Maintenance Heat. Vent. Wire.										
450	Repairs to Mach. Elec. Furn.										
451	Replacements & Improvements to Mach. Elec. Furniture										
480	Maintenance Automobiles										
	TOTAL										
	Budget Correction for Variation in Productive Labor										
	Corrected Total										
	% Actual Expense to Budget Expense										

FIGURE 7. *Form for manufacturing expense budget*

the figures or percentages given are illustrative only, and are hypothetical.

From past experience, then, and with the above fundamental relationships and limits set, the individual budget can be set up. The management should give the various department heads and junior executives the general policy for budgeting, and the fundamental relationships of the various factors to be considered, with their limits, for their use in setting up the individual budgets. They should then be permitted to set up and work out these individual budgets.

After these have been set up, they should be co-ordinated with the master budget, and such adjustments made as subsequent comparison proves advisable to meet the conditions and requirements of the total or master budget.

Many executives make two errors due to a misconception when contemplating the application of a budget procedure to the control and regulation of their business:

1. They have mental indigestion because they assume that a complete system of budgeting must be inaugurated.
2. They have fluctuations in their sales volume due to seasons, or other causes, and they assume that the budget is inflexible.

With regard to the first error, the important fact to bear in mind is that the way to "resume is to resume"; the way to "start is to start." It is not so important where you start as it is to start. Pick out the particular phase of your activities that you desire to control initially. It may be the budgeting of indirect expenses, the budgeting of sales, or inventories, or selling expense, but whatever it is try one phase first. Educate one group of your organization initially. Get this working smoothly and then go on to the next and you will meet with success. If you try to do it the other way round, while it can be done and done successfully, yet it is much more difficult and usually requires expert outside professional assistance to do it quickly and effectively.

The second error is usually committed because flexibility is not provided, and when actual results are compared with a predetermined budget, but not adjusted to meet variations beyond the management's control, everyone is disgusted and the "die hards" say, "There, I told you so. That is all right for so and so, but our business is different. We cannot do that, etc., etc."; whereas the difficulty is due to a misconception and to faulty budgeting technique rather than to anything fundamentally wrong with the general principle.

TABLE 3

PERCENTAGE RELATIONSHIP

Volume	*% Capacity*	*Capacity Increment*
$ 500,000	41.6%	...
600,000	50.0	8.4%
700,000	58.3	8.3
800,000	66.6	8.3
900,000	75.0	8.4
1,000,000	83.3	8.3
1,100,000	91.6	8.3
1,200,000	100.0	8.4

Suppose that we set up a table for comparative results of operation, taking into account the principal factors, and their variation due to changing volume, such as is presented herewith by Messrs. Bigelow, Kent, Willard & Company. (See Table 2.)

The corresponding operating capacities are shown in Table 3.

One hundred per cent capacity is usually assumed to be that capacity which is obtained when correcting 100 per cent capacity for interruptions to production, due to operators out, machines down for repairs, idle time, etc., or the normal interruptions. In other words, suppose a study shows that when these interruptions to production are at their irreducible normal minimum, this represents 85 per cent of theoretical full production. Then this 85 per cent is taken as the practical 100 per cent capacity and the operation is worked out from that point.

BREAK-EVEN POINT

Suppose then that, after these various items were worked out, it should show, as was assumed in this case, that the break-even point was 58 per cent of capacity. Bear in mind, however, that this break-even point is never, as a rule, a fixed point. It can move up or down for a number of reasons. If the competition is severe, the

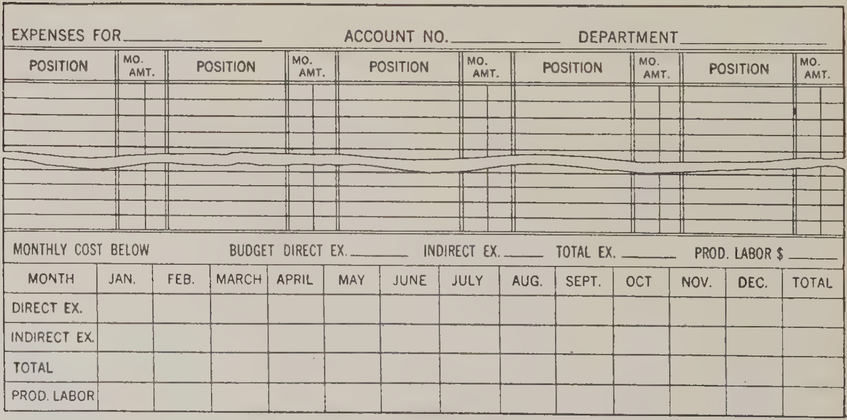
Table 4

CORRESPONDING OPERATING CAPACITIES IN PER CENT

	Estimated	*Actual*
Sales	$900,000	$800,000
Per Cent Capacity	75.0%	66.6%
Materials	37.2	37.8
Direct Labor	26.0	26.5
General Factory Expense	16.5	17.0
Cost of Sales	79.7	81.3
Gross Profit on Sales	20.3	18.7
Selling Expenses	7.1	7.3
Selling Profit	13.2	11.4
Administrative Expense	6.5	7.0
Operating Profit	6.7	4.4

gross margin will decrease, if expenses and cost of production remain the same, and the point will move up. If cost of production, by the substitution of lower-priced materials, more effective use of materials, etc., increased application of power, mechanization of the production equipment, is lowered and the selling prices remain the same, the point will move down. So this position of the break-even point must be periodically checked to determine its position relative to the 100 per cent capacity.

Assume for the moment that prices are stabilized, and the break-even point of the business under consideration is 58 per cent. Now,



EXPENSES FOR__________ ACCOUNT NO.__________ DEPARTMENT__________

POSITION	MO. AMT.	POSITION	MO. AMT.	POSITION	MO. AMT.	POSITION	MO. AMT.	POSITION	MO. AMT.

MONTHLY COST BELOW BUDGET DIRECT EX.______ INDIRECT EX.______ TOTAL EX.______ PROD. LABOR $______

MONTH	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT	NOV.	DEC.	TOTAL
DIRECT EX.													
INDIRECT EX.													
TOTAL													
PROD. LABOR													

Figure 8. *Form for summary of expenses and production labor*

for each increment of $100,000 of sales volume certain results from operation are obtained, if the various items making this up are regulated and controlled.

Suppose for a given month the sales budget was forecast as $900,000, or 75 per cent of capacity, with the corresponding relationship of the other factors, whereas before the end of the month preceding it was apparent that the volume of new business coming in was at the rate of $800,000, or 66 2/3 per cent of capacity. The variable items in the several budgets, sales budget included, should then be adjusted accordingly and the various items regulated to suit the situation imposed by the new conditions, providing it is determined that this is permanent.

Then from Table 2 will be seen that the percentage relationship between the various items of direct costs, indirect costs, profit and loss, are as shown in Table 4.

Figures 5 to 8, inclusive, show forms used for the regulation of the manufacturing expense budget.

The adjustment and regulation of the budgets should be centralized in the hands of the comptroller, chief accountant or treasurer, as the case may be, depending upon the logical individual in the organization and type of organization. He can then point out the variances and divergences in each budget and call the attention of the individual responsible for its control to these facts. The management, either through copies of individual budgets or through the master budget, can check up the performance as well.

W. S. Clithero, director of budgets of Armour & Company, states: "In a business where the company has a comptroller, the budgeting procedure should be under his supervision, or if it has no comptroller, should be under the executive exercising the functions of the comptroller."

Continuing a discussion of the subdivision of budget items for the purpose of check, comparison and control, Figure 9 shows the arrangement of the items of Administration Expenses, and Figure 10 of Distribution Expenses. It will be noted that provision is made for the adjustment of the budget up or down, depending upon conditions, so that at all times a comparison is made between the budget, the corrected or adjusted budget, and the actual expenses as incurred.

SCHEDULE______

GENERAL EXPENSES

Total Company — DEPARTMENT   MONTH March 19__

ACCT. No.	NAME	THIS MONTH	LAST MONTH	CUMULATIVE	MARCH BUDGET
	ADMINISTRATION EXPENSES				
	Salaries				
21	Officers—Secys.				
23	Clerical Employees				
25	Treasury Dept.				
26	General Acctg. Dept.				
27	Other Employees				
30	Rent, Light, Heat Ex. Off.				
32	Office Equip., Rep. & Repl.				
34	Traveling & Entertainment				
36–37	Tele. & Teleg. Exp.				
38	Staty. & Office Supplies				
39	Donations				
41	Depreciation				
43	Legal Consulting				
45–50	Other Expenses				
	TOTAL				
	NON-DEPT'L EXPENSES				
147	Corporate Taxes				
148	Patent Expenses				
149	Disc. & Exp. on Bond Issue				
150	Ac. against Poss. Loss				
152–155	Unabsbd. Transport'n				
156	Warehouse Expense				
	TOTAL				
	MISC. INCOME				
161	Int. on Notes A/C Rec.				
162	Misc.				
163	Return on Investment				
164	Purchase Discount				
165	Spool Profit				
	TOTAL				
	CHARGES TO INCOME				
171	Int. on Notes Pay.				
172	Int. on Accts. Pay.				
173	Int. on Bonds				
174	Sales Discounts				
	TOTAL				

FIGURE 9. *Arrangement of administration expenses*

SCHEDULE________

GENERAL EXPENSES

Total Company MONTH March 19__

DEPARTMENT

ACCT. No.	NAME	THIS MONTH	LAST MONTH	CUMULATIVE	BUDGET
	DISTRIBUTION EXPENSES				
	Salaries				
51	Officers—Dept. Hds.				
53	Advertising				
54–57	Selling Force Sales Rec.				
58	Terr. Correspondents				
59	Stenographers				
60	Sales Engr.				
62–67	Clerical Employees				
68	Foreign Dept.				
69	Credits Collection				
70–71	Billing Distr. Acctg.				
73–76	Traveling—Entertainment				
77–78	Tele. & Teleg. Exp.				
79	Postage				
81	Staty. & Off. Supplies				
84	Off. Equip., Rep. & Repl.				
85–90	General Advertising				
92–99	Radio Advertising				
92A–99A	Automotive Advertising				
101–103	Catalogues				
101A–103A	Catalogues				
105	Insurance				
106	Sales Commissions				
107	Losses Due to Errors				
109	Collection Fees				
111	Legal Consulting				
112–113	Foreign Sales Exp.				
115A B	Sales Development Exp.				
117	Depreciation				
118–119	Rent				
120–125	Other Expenses				
126–135	Newark Branch				
136–145	Cleveland Branch				
	TOTAL				

FIGURE 10. *Arrangement of distribution expenses*

SALES AND PRODUCTION COMPARISON FOR INVENTORY CONTROL

As of April 30, 19

Products or Lines of Merchandise	No.	Est. Net Sales for May	Net Sales for Apr.	Net Sales for Apr. Last Yr.	In Stock May 1 at Selling Prices		Total Inv. at Selling Prices	Max. Point This Year	Inv. Gain or Loss in Mo.	Inv. Quota Apr. 30 at Selling Prices	May 1 Value of Orders on Books	Net Prod. for Apr. at Selling Prices	Net Prod. Apr. 1926 at Selling Prices
					Standards	Specials							
	1												
	13												
	14												
Total for High Month.													

All figures in thousands of dollars

Figure 11. *Sales and production comparison*

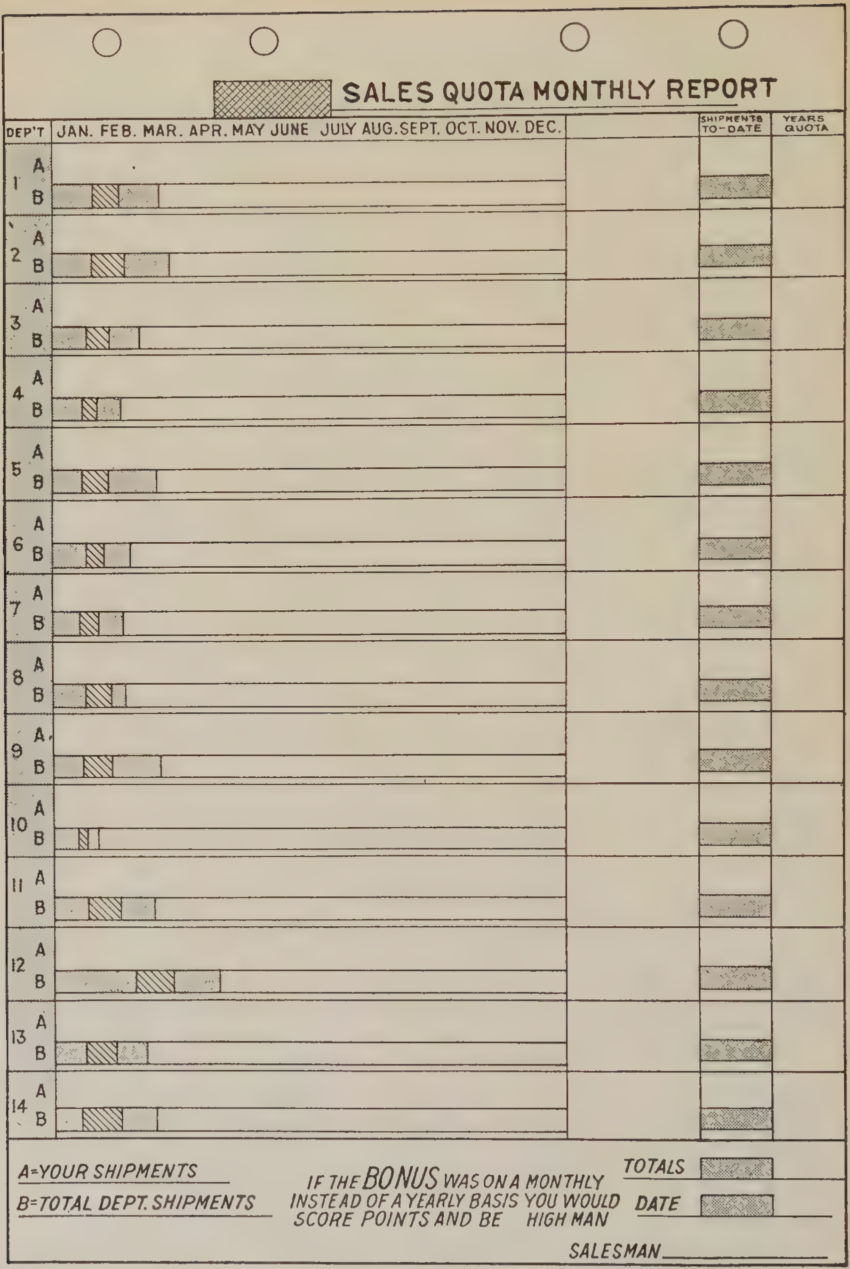
Figure 11 shows a form for the regulation of production and inventories, and the correlation of production with sales demand. All the essential and necessary information is here presented on one sheet without confusion, and reduced to its simplest terms. The simpler the information can be, the more readily it can be assembled on time (this is of paramount importance) and the more readily will the information be used for effective regulation.

If we can impress upon the various members of an organization who will be primarily responsible for the budgeting details, and say to them, "Gentlemen, we would rather have your individual measurement of your prospective performance (departments, etc.), what you propose to do, and what you believe you can do, than any other measurement anybody else can put forth," you have gone far in selling the budget idea.

When the budget is handed down from the top and composed in detail by a few, but where those who are to operate the detailed budgets have been ignored and not consulted, then you are in for trouble, because you have not sold the budget idea to those to whom you must necessarily depend for its successful operation. It is common sense and human nature for each one of us to try and live up, as a matter of personal pride, to those standards of performance we set for ourselves, or for our group, and to strive to attain the goals predetermined.

You will find after you make the general studies preparatory to placing a business on a budget basis, that your organization will need to be realigned. This is almost invariably the case. Functions that should be related and correlated are performed, or their operations supervised by different individuals in the organization. It is essential, therefore, to give each executive, junior executive and department head control over those functions that should permit him to be responsible for a given group or series of activities. Responsibilities and duties should be definitely fixed; the proper authority granted so that the individual can properly exercise control over those things for which he is definitely responsible. Otherwise you will find that the budget is the finest means yet devised by human ingenuity to "pass the buck," and you will experience considerable trouble to isolate and locate it.

Much has to be learned about the preparation of budgets for an individual business, but if we absorb the idea that a carefully devised budget, suited to the particular requirements of the business,



SALES QUOTA MONTHLY REPORT

DEP'T		JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.		SHIPMENTS TO-DATE	YEARS QUOTA
1	A				
	B				
2	A				
	B				
3	A				
	B				
4	A				
	B				
5	A				
	B				
6	A				
	B				
7	A				
	B				
8	A				
	B				
9	A				
	B				
10	A				
	B				
11	A				
	B				
12	A				
	B				
13	A				
	B				
14	A				
	B				

A=YOUR SHIPMENTS

B=TOTAL DEPT. SHIPMENTS

IF THE BONUS WAS ON A MONTHLY INSTEAD OF A YEARLY BASIS YOU WOULD SCORE POINTS AND BE HIGH MAN

TOTALS

DATE

SALESMAN ____________

FIGURE 12. *Sales Quota monthly report*

RECAP. OF NET SHIPMENTS FOR PERIOD ENDING ______ 19__

SALESMAN ______ TERRITORY NO. ______ PAGE NO. ______

STATE ______ TOWN ______ CUSTOMER	TOTAL SHIPMENTS	SHIPMENTS PERIOD ENDING		MONTH LAST SHIPMENT	NO. OF VISITS	DATE OF LAST VISIT	______ (MONTH) VISITS
	YEAR 19__	19__	19__				
Customers Shown							

FIGURE 13. *Recap. of net shipments—customers shown*

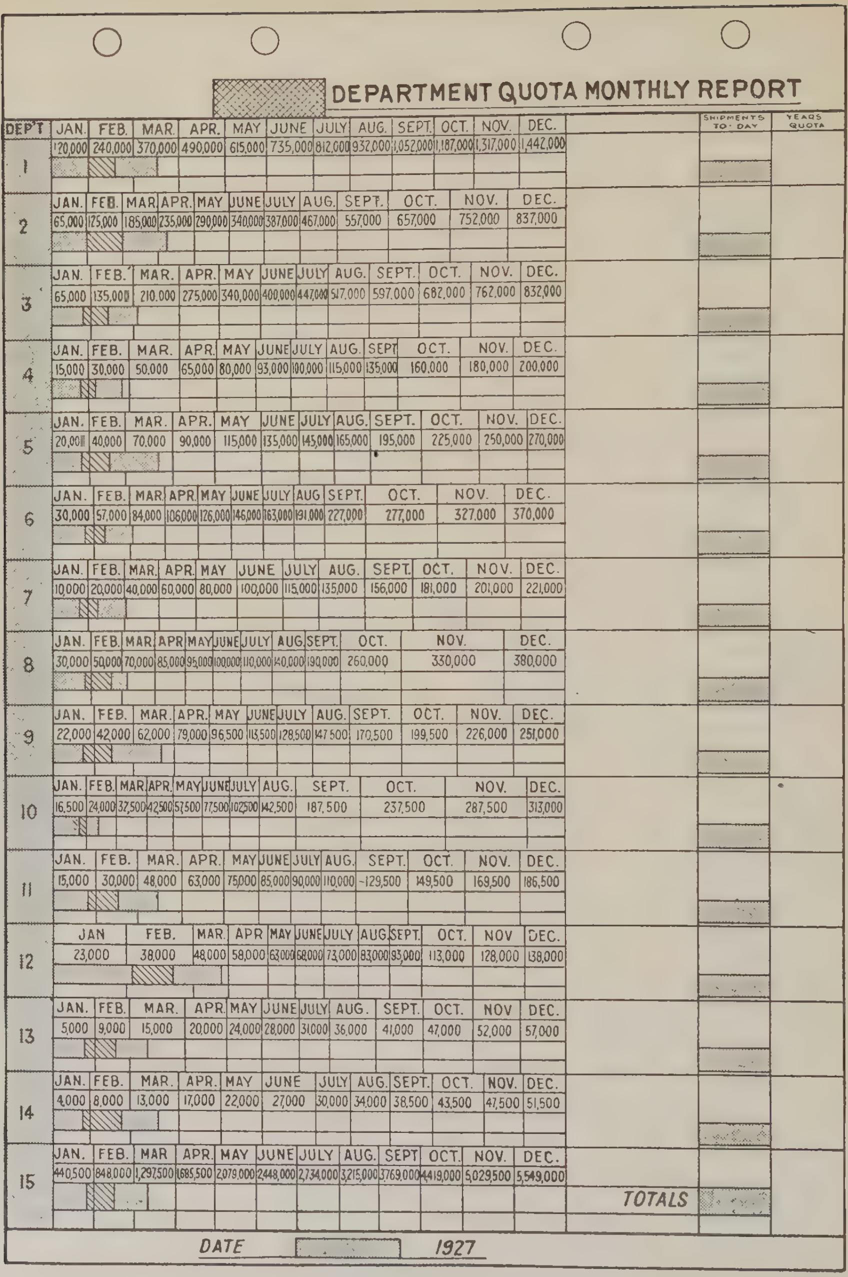
enables us to be master of the business rather than to be mastered by it; that it is an exceedingly useful tool of modern management, then you will not be long in seeking ways and means of being master of your job and your business.

Fred W. Shibley, vice president of the Bankers Trust Company, says: "No cut-and-dried plan will apply to every business, for each business is different from every other business in many essential details. Therefore, a budget must be cut and fitted and adapted to a business, just as a gown is fitted to a woman or a coat to a man."

The primary object of regulation by budgetary procedure is twofold:

1. Promulgation and design of a predetermined plan of operation.
2. The execution of that plan, and the means of measurement, that is, of gaging the actual performance with the predetermined plan of operation.

Assume plans are made for the year to earn a certain percentage of profit on the invested capital, which is usually a different percentage from the profit on sales. The comptroller then analyzes the various factors and the story usually is that if certain quotas of the product or products can be manufactured and sold, if inventories



DEPARTMENT QUOTA MONTHLY REPORT

DEP'T	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.		SHIPMENTS TO-DAY	YEARS QUOTA
1	120,000	240,000	370,000	490,000	615,000	735,000	812,000	932,000	1,052,000	1,187,000	1,317,000	1,442,000			
2	65,000	125,000	185,000	235,000	290,000	340,000	387,000	467,000	557,000	657,000	752,000	837,000			
3	65,000	135,000	210.000	275,000	340,000	400,000	447,000	517,000	597,000	682,000	762,000	832,000			
4	15,000	30,000	50,000	65,000	80,000	93,000	100,000	115,000	135,000	160,000	180,000	200,000			
5	20,000	40,000	70,000	90,000	115,000	135,000	145,000	165,000	195,000	225,000	250,000	270,000			
6	30,000	57,000	84,000	106,000	126,000	146,000	163,000	191,000	227,000	277,000	327,000	370,000			
7	10,000	20,000	40,000	60,000	80,000	100,000	115,000	135,000	156,000	181,000	201,000	221,000			
8	30,000	50,000	70,000	85,000	95,000	100000	110,000	140,000	190,000	260,000	330,000	380,000			
9	22,000	42,000	62,000	79,000	96,500	113,500	128,500	147 500	170,500	199,500	226,000	251,000			
10	16,500	24,000	32,500	42500	57,500	77,500	102500	142,500	187,500	237,500	287,500	313,000			
11	15,000	30,000	48,000	63,000	75000	85,000	90,000	110,000	129,500	149,500	169,500	186,500			
12	23,000	38,000	48,000	58,000	63000	68000	73,000	83000	93,000	113,000	128,000	138,000			
13	5,000	9,000	15,000	20,000	24,000	28,000	31000	36,000	41,000	47,000	52,000	57,000			
14	4,000	8,000	13,000	17,000	22,000	27,000	30,000	34000	38,500	43,500	47,500	51,500			
15	440,500	848,000	1,297,500	1685,500	2,079,000	2448,000	2,734,000	3,215,000	3769,000	4419,000	5,029,500	5,549,000			
													TOTALS		

DATE ________ 1927

FIGURE 14. *Department quota monthly report*

RECAP. OF NET SHIPMENTS FOR PERIOD ENDING ____________ 19__

SALESMAN ____ TERRITORY NO. ____ PAGE NO. ____

Town	State	Total Shipments	Shipments Period Ending			
		Year 19__	19__	19__		
Towns Shown						

FIGURE 15. *Recap. of net shipments—towns shown*

are regulated (downward), if manufacturing, engineering, administrative and sales expenses can be kept at a minimum, the desired profit can be made. A detailed budget is then set up for each division and the sales quotas assigned.

Figures 12, 13, 14, 15 and 16 show how the plan can be administered and the actual performance checked against a predetermined plan of operation.

By a budget procedure we have been enabled to regulate our production with sales demand; to regulate our inventories and reduce them; to control our operating expenses, factory burden, sales and administrative expenses, and reduce them; to regulate and control our bank loans; to control our expenditure for capital account; and to control and reduce our maintenance expense.

Fordham and Tingley, in their book "Organization and Budgetary Control in Manufacturing," emphasize the steps in the use of a budget substantially as follows:

"1. The management determines the desired profit, or attainable profit.
2. The comptroller analyzes:
    (a) Costs.
    (b) Markets.

Ratio	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Net Sales Billed to Quota												
Cumulative												
Distribution Exp. to Budget												
Cumulative												
Administrative Exp. to Budget												
Cumulative												
General Exp. to Exp. Absorbed												
Cumulative												
Mfg. Exp. to Budget												
Cumulative												
Mfg. Exp. to Exp. Absorbed												
Cumulative												
Factory Operating Capacity to Normal												
Cumulative												

FIGURE 16. *Monthly comparison of operating ratios*

(c) Expenses.
(d) Determines overall sales quotas.
(e) Allocates money per division.
(f) Gives each division head his overall allotment. (Division head breaks this down and adjusts with comptroller.)
(g) Compiles master budget from adjusted division budget.
(h) Co-ordinates with sales demand.
(i) Checks expenses and actual performance with budget.
(j) Compiles monthly and quarterly statements for management, showing the variances and deviations.

3. Management checks and regulates performance."

They state that the advantages are, substantially, these:

1. Forces preplanning.
2. Requires centralized executive control.
3. Forces proper organization.
4. Brings about co-ordination of sales and production plans.
5. Helps eliminate peaks and valleys.
6. Increases and maintains operating efficiency.
7. Enables standardization of product, equipment, processes and methods.
8. Regulates inventories.
9. Permits costs to be used for standards and for regulation rather than as history.
10. Prevents unauthorized expenditures.
11. Enables financial planning and reduction of costs of capital.
12. Requires a study of expenses in advance, and their control and reduction.
13. Provides a definite goal.
14. Provides definite standards of comparison and of performance.

CONTROLLING PRODUCTION THROUGH THE BUDGET

By JOSEPH H. BARBER
Assistant to President, Walworth Company

BUDGETING an industry means co-ordinating all of its activities. Projected plans must be correlated with possibilities, probabilities and limiting factors. Hopeful policies must harmonize with cold facts. Operations must meet requirements. Actual realization must be checked back against expectations. And every activity creating expenditure must be proportioned according to its ability to add to revenues or to reduce costs and thus contribute a share of net profits.

In adequate industrial budgeting, physical and financial figures must dovetail. Budgeting a business should result in a co-ordination of sales quantities and price discounts, of production lots and unit costs, of physical equipment and financial investment—so that the sales revenues will yield a net profit after all costs.

The practice of budgeting is an active expression of the principle of "the sales dollar." This principle stresses the fact that all the costs and expenses of an industry can be paid for only out of the sales dollars that customers will pay for the products of the industry. This implies that out of each dollar actually gotten, only a certain number of cents can be allotted to pay the costs of a given activity of the business. If any department spends more than its allotted share of the total sales dollars, it penalizes other departments or creates a loss. The principle of the sales dollar argues that all activities must be proportioned according to sales revenues, and it prescribes the order in which the several functional budgets must be developed.

It is hard to get away from the natural tendency to check up past progress and elaborate future plans at the end of the calendar year. The financial books are being formally closed and reopened then and many people are exchanging opinions concerning prospects at that time. So the principle of "the sales dollar" says we must begin with sales, and our habits say we must estimate annually. Then when we do estimate, we simply attempt to approximate in advance what are the real probabilities as to sales conditions.

"Hunch" guesses are not countenanced because the real probabilities are very likely to resemble actual past experiences and to be affected by economic prospects, against which all estimates are checked. What we desire is a really honest estimate of probable revenue.

Our sales estimates result from the co-operative effort and judgment of the managers and officials of the business. The estimates are built up synthetically by territories, each of which is in charge of a local manager. Each local manager's territorial estimate, by product lines and by total, is reviewed in turn by the regional manager, by the general sales manager, and by the central planning section of the president's office. Each reviewer places his own estimate alongside that of the manager, and final consideration of them all is given by the president, who fixes the sales budget.

This same sort of synthetic development of estimates finally approved by the president is carried out successively with reference to production schedules, commodity purchases, expense purchases, payroll and financial items. The final authorizations of each estimate

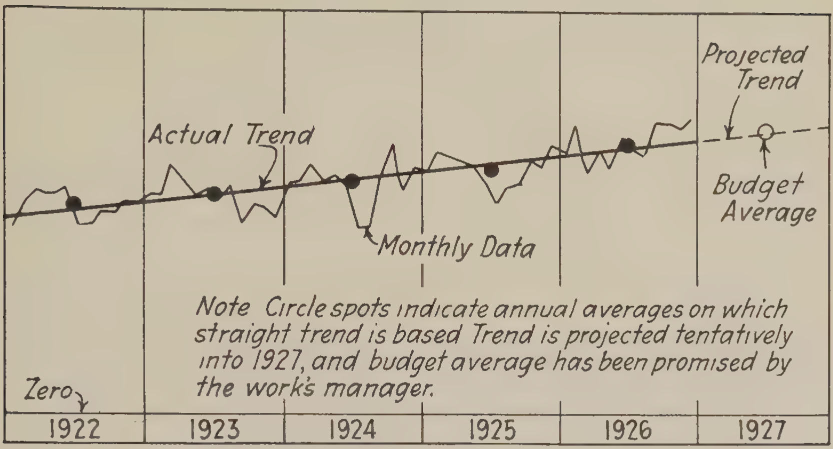


FIGURE 17. *Tonnage output per man-hour*

are entered upon a master summary. Though condensed in form, the summary does reveal the expected sales versus commitments and the resulting net profit, and it tells this story for each financially responsible unit of the company. If there is any indicated lack of balance reflected in the master total, the erring units can be identified upon the master summary and we can trace down through the subsidiary controls until we locate the elements that need adjustment. Thus the principle of the sales dollar is applied in the budget. In total—or by units—we cannot spend more than we get and still hope for profit.

TERRITORIAL SALES ESTIMATES

It was said that the principle of the sales dollar prescribed the order in which the several functional budgets must be developed. Territorial sales estimates come first. Each territorial estimate of sales indicates the amount of factory product probably to be sold in that territory. Experience records enable us to allocate the factory demand of this territory to the four producing works. When all territory totals have been distributed to the works, we add up the total demand likely to fall upon each of the works. Then each such works total, by value and by its quantity equivalent, becomes the over-all estimate of that works' total revenue and of its total production.

Such a quantity total might be broken down to product classes by ratios based upon the historical evidence of each class's relative importance. In our experience we have found it desirable to run an independent quantitative forecasting analysis for each important product class at each works. These product estimates are priced, added up to a total and harmonized with the first-mentioned over-all works' total which represents the allotted portion of the territorial sales. This practice just as certainly assures the tie-in of production schedules with sales estimates, but there is greater certainty that each individual product estimate is a natural continuance of its own experience.

When the central planning section has checked its product class estimates and harmonized them with the over-all total, it enters the essential figures upon an executive review sheet of the design shown in Table 5. Such a schedule is prepared once a quarter. Its data always include estimates of orders for a full twelve months ahead.

This schedule serves as background material for fixing the production rate, even though the specific calculations in columns A to K relate to but a six-month span. Note, for instance, that the committee's authorization in column L is entered without a complete calculation and may be freely affected by judgment. Such a sheet is refigured each successive quarter, always with a view to averaging the rate of production.

The orders-received estimates are assumed equivalent to shipments estimates. Desirable July 1 stock levels are shown in column

TABLE 5

PRODUCTION ESTIMATED SCHEDULE

PRODUCT CLASS	ESTIMATES BY	ORDERS				INVENTORY			PRODUCTION			FOR COMPARISON			
		EXCESS UNFILLED ORDERS	1ST. QUAR	2ND. QUAR.	COMB. QUARS.	PREDICTED AMT. 1/1/27	DESIRED 7/1/27		1ST & 2ND QUARS		COMMITTEE AUTHORIZED PRODUCTION	ORDERS			PREV. PROD. QUOTA
							AMT. OF INV.	AMT. OF CHANGE	TOTAL	AVE.		3RD QUAR.	4TH QUAR.	YEAR'S TOTAL	
		A	B	C	D	E	F	G	H	K	L	M	N	P	Z
					A+B+C			F−E	D+G	H÷2					
X	P+S	0	435	480	915	400	375	−25	890	445	440	480	405	1800	470
	SALES	"	400	480	880	"	400	0	880	440		–	–	–	
	PROD.	"	375	450	825	"	375	−25	800	400		–	–	–	
Y	P+S	0	375	360	735	255	300	+45	780	390	000	385	360	1480	410
	SALES	"	000	000	000	"	000	+00	000	000		–	–	–	
	PROD.	"	000	000	000	"	000	+00	000	000		–	–	–	

F, and the production rate is figured to secure whatever stock liquidation or increase is figured in column G. The planning section first enters figures upon its line. Then, the schedule receives the corresponding estimates by others who may be able to suggest corrections for special factors possibly not considered by the planning section when converting the territorial estimates into production tonnages. The sheet is next reviewed in committee (the

TABLE 6

SUMMARY OF 1927 COST OF SALES CALCULATION

	1927 Cost of Sales Volumes Priced Up to 1926 Average Unit Cost Values	Expected Change in Unit Values Caused by External Factors or Planned for	1927 Cost of Sales Volumes at 1927 Expected or Planned Unit Cost Values
Raw Materials..................	$1,088,000	—4.4% (a)	$1,040,000
Direct Labor (Day-Rate)........	554,000	—5.0% (b)	526,000
Direct Labor (Piece-Rate).......	280,000	—1.2% (c)	277,000
Indirect Payroll................	815,000	—5.0% (d)	774,000
Clerical & Supervision Payroll....	275,000	+1.1% (e)	278,000
Expense Materials..............	462,000	+0.4% (e)	464,000
Total Cost of Sales.............	$3,474,000		$3,359,000
Reduction in Total Cost of Sales Due to Improvement in Unit Costs......			3.3% (f)

(a) Decrease allows for 3.0 per cent downward drift expected in general materials and commodity prices, but also contemplates a $15,000, or 1.4 per cent, saving due to scrap and other material economies.

(b) Day-rate direct labor will be decreased in the same percentage as the 1927 increase in output per man promised by manager.

(c) Theoretically, greater output per man would not effect any decrease in unit payroll costs for wages paid per number of pieces output. Yet improving output results partly from management's enterprise in perfecting conditions surrounding unit jobs. This necessitates and justifies resetting of piece rates to allow for those changed conditions. The percentage decrease estimated here represents the unit cost reduction likely to result from such justifiable revisions in piece rates.

(d) Indirect labor cost per ton must decline by same percentage as direct labor costs per ton if usual co-ordination between direct and indirect labor is to be maintained. This percentage decrease equals the percentage increase in the budgeted output-per-man. See footnote (b) above.

(e) Both overhead payroll and expense materials estimates are synthetically built up by departments to a total budget as described in the text. The percentages and amounts shown here are gotten from that detail expense budget data. The increases in overhead are justifiable only if they lead to a realization of the savings calculated in the other items.

(f) Note that this 3.3 per cent reduction in overall costs slightly exceeds the 3.0 per cent decline contemplated, per footnote (a), in general commodity prices and therefore in this works' sales prices. This favorable comparison indicates a slight increase in profits in spite of the price decline.

estimators, with the president and treasurer) and they enter the finally authorized amounts in the "committee" spaces. The cycle of control is completed when each works translates the allotment by product classes into control by items and by parts.

As stated above, we attempt always to gain constant adjustment to an averaged rate of production, often preferring to finance increased stocks prior to an expected peak of demand, rather than to fire and rehire our trained workers. Frequently it has been declared that a primary result of forecasting and budgeting is inventory reduction. Yet, if one analyzes the month-by-month curve of demand in almost any industry selected at random, he cannot fail to see how uneven the production output would be if it were possible to duplicate the order curve exactly. The most expensive ingredients in our business today are trained labor and effective organization. The least expensive ingredient, judged by effective results, is the interest charge on just enough additional stocks to guarantee customer service and to build up goodwill. With us, it is good business to aim for the economies of steady production. And this is so even if a little extra interest charge results from the surplus stock we build up at times because of an erratic demand.

Controlled production is a major problem for a manufacturer, but, after all, we are primarily business men and only secondarily manufacturers. If a manufacturing control can be founded upon forecasts, is it not even more desirable to base a business control upon forecasts? Business forecasts must be concerned with profits. Certainly forecasts should predict the probable volume of production and its assortment, should aid in formulating labor policies, in defining purchasing schedules, in fixing the seasonal distribution and assortment of stocks, and in prescribing when and where to expand, contract or reallot plant facilities. But it is quite as important to evaluate the probable effect of all these upon the "cost to make" and upon profits.

DIRECT AND INDIRECT LABOR BUDGETS

Space will not permit touching upon all of these factors. If the production allotment by product classes has been fixed, conversion factors may be applied in developing a purchasing schedule which, in turn, can be priced up for developing a commitments budget. With the production schedule in hand, we may also refer to our labor-budget ratios and figure an allowance of 10 machine-finishing men per hundred tons of brass valve output, for instance. When a personnel list by departments is completed and priced up on the basis of average wage rates, we have the direct payroll budget. Similarly, the indirect payroll budget calculation would proportion indirect to direct labor according to acceptable standards.

The overhead factors, department by department, are next analyzed segregating fixed or "non-controllable" expense items from those that are variable. The controllable expense budgets are fixed in accordance with the adopted production rate in such a way as to maintain or improve their usual per-ton relationships. It is possible that the overhead expenses may be permitted an increasing share of the sales dollars, but only if that increasing share will guarantee a proportionately decreased share for direct costs.

SUMMARY FROM SALES DOLLAR VIEWPOINT

Table 6 summarizes these various budgets from the "sales dollar" viewpoint. A complete sales dollar analysis would break down the 100 per cent total into proportionate divisions to indicate a certain number of cents allowable for each class of expenditure. Each class would include a homogenous lot of items which, as a group, would be likely to react to the same economic causes. Our unit costs are built up in this way, so it is possible to "price up" the total estimated cost of sales tonnage according to the several economic elements that are represented in that total.

The first column of Table 6 shows these various economic elements of the total cost of sales as if the conditions of 1926 were to be duplicated. The second column with its explanatory footnotes summarizes the economic changes expected, and the final column yields the total cost of 1927 sales. This total cost, together with certain other expense and financial charges, is deducted from that works' over-all sales revenue and the balance remaining is the works' net profit for the year.

Executive review of such a summary might question the possibility of cutting the direct labor cost at the rate of 5 per cent. Actually, in Figure 17, the long record reveals an increasing effectiveness in the output per man. Here we see, in a single summary, some of the tangible benefits accruing from earlier attempts toward regularization of employment, maintenance of organization, consolidation of production lots, and development of management technique. We know efficiency has improved. We have supporting records by individual departments and can make comparisons between works. Actually, we should be "slipping" if we did not expect that 5 per cent increase in 1927.

Finally, having derived an estimate of works sales, costs, expenses and net profits, we must ask, "What about the budgets covering branch warehouse operations, salesmen's activities, regional supervision, central office accounting, financing and general administration?" All of these variable activities must of necessity be paid for out of whatever gross profit margin will exist between the selling value and the cost to purchase from the factories. The tides of external economic conditions are forever shifting. The knottiest problem in all business control, although often not so recognized, is how to squeeze all those operating expenses inside the gross profit margin and leave an adequate net profit.

TABLE 7

AVERAGE BRANCH DEPARTMENTAL EXPENSE RATIOS

	DEPARTMENTAL EXPENSES (Variable Items Only)							OVER-ALL TOTALS		
Departmental Expense	Administrative	Selling	Accounting	Transportation	Regular Stores & Shipping	Pipe Shop	Pipe Shipping	Total Variable	Total Fixed	Grand Total
Class of Sales That Expense Is Compared with:	Grand Total	Grand Total	Grand Total	Out of Stock Only	O/S Sales Exc. Pipe	O/S Pipe Sales Only	O/S Pipe Sales Only	Grand Total	Grand Total	Grand Total
Branch A.....					2.93					
Branch B.....					5.32					
Branch C.....					3.25					
Etc..........					Etc.					
Etc..........					Etc.					
Average Branch.....					3.16					

We must first interpret the significance of any forecast change, representing a decline in the volume of sales, let us say. Other things being equal, a decline in volume means an exactly parallel decline in the gross profit income. If expense, in turn, is not budgeted to show a reduction also exactly in parallel, so that it calls for no more than its share of the sales dollar, then net profit will be threatened with severe reduction and possibly with elimination.

A supplementary Table 7 is added here to show how it is possible to isolate and identify savings possibilities by an extension of

TABLE 8

SUMMARY OF ESTIMATED CONSOLIDATED PROFIT AND LOSS STATEMENT

		TOTAL SALES	GROSS PROFIT		REGULAR EXPENSE		TRADING PROFIT	FINANCIAL CHARGES	NET PROFIT
			Ratio to Sales	Amount	Ratio to Sales	Amount			
Grand Total....	1926								
	1927								
Total Branches.	1926								
	1927								
Branch A...	1926								
	1927								
Branch B...	1926								
	1927								
Branch C...	1926	$2,182,010	18.62%	$406,290	11.81%	$257,695	$148,595	$33,972	$114,623
	1927	2,100,000	18.50%	388,500	11.15%	234,150	154,350	36,000	118,350
Etc........	1926								
	1927								
Total Works	1926								
	1927								
Boston Works...	1926								
	1927								
Etc........	1926								
	1927								

the sales dollar analysis. The assumption here is that if the average branch can afford only so many cents out of each dollar for a certain activity, then any branch spending a greater proportion ought either to justify the condition or else proceed to bring the expense into line. Note the evidence here against Branch B, for instance.

SUMMARY OF ALL BUDGETS

In spite of the broad scope of activities analyzed, it should be possible to summarize all the projected budgets upon a single page. This is most effectively done if we speak in the language of the accounts, and at the same time give expression to our sales dollar viewpoint. Table 8 shows such a summary. Each unit of the company, having a manager responsible for the financial success of its operation, is given separate recognition. The actual line-up for the closing year is handy for comparison with the budget prospect for the opening year.

We begin with sales; show the gross profit after production or purchase cost; deduct regular expenses and financial charges; and reveal the net profit remaining from the estimated sales dollars. If for a particular unit the grand total summary shows there is no profit or an inadequate profit, it is at once possible to earmark the units needing pressure to improve their showing. It will be recalled that it was such a summary as this, in 1926, that led us to strenuous efforts to reduce the overhead expenses which we were then paying for out of gross profit margin of our sales dollar.

That was perhaps an exceptional example of advantages gained from "sales dollar" budgeting. Ordinarily, the great benefits are gained gradually by applying corrective control to one of the important variable factors after another. There may be keener competition and narrowing profit margins. But an advantage can be gained somehow, maybe in shop labor cost per unit, maybe in expense, or maybe somewhere else. Accomplishment in such a direction will then release a surplus of dollars for more intensive selling effort to meet the increasing competition. Budgeting in an industry can prove its ability to co-ordinate all its activities; it can find ways to proportion effort with greater effectiveness; and it can tell the administrator whether present plans will leave a slice of the sales dollar for net profits.

BUDGETING FACTORY OPERATING COSTS

By E. E. BRINKMAN

Industrial Engineer, Holeproof Hosiery Company

TO head off the tendency toward higher costs, characteristic of every factory, the Holeproof Hosiery Company some time ago decided to adopt budgetary control methods. As a preliminary step a simple and complete cost and record system was first developed.

After the above system had been in operation for a few years, the control record system was taken as a base for the budgetary planning of costs and performance, effected gradually throughout a year's time. Experiments with the operation of budgets and their usefulness in cost reductions "sold" everyone on their need before they were officially put into effect.

As this system of budgetary planning and control of factory operation now exists after three years' use, it involves two separate problems:

1. Planning operations in advance and making up the budget for carrying out this plan;

2. Following up the budget to be assured of adherence to its provisions for guidance.

Obviously, the basis of all budgeting of factory operations is the quantity we expect to produce. This is determined from the sales quota, modified by anticipated increases or decreases in inventories during the budget period.

At a time when reduced inventories, increased stock turnover and better service to customers are of vital importance, this modification of the sales quota for use as a production budget is a big subject and really lies beyond the scope of the present discussion.

In laying out a production plan for budget, the first step is analysis of the previous budget period to see how closely the production budget has been fulfilled. Causes of actual variations from the budget forecast enable us to avoid a repetition of errors in our production plan for the next budget period.

At this time also a comparison of actual and budgeted expenses is very illuminating, and suggests the items of expense that must receive special attention in making out the new budget, to bring the cost items into line with current requirements.

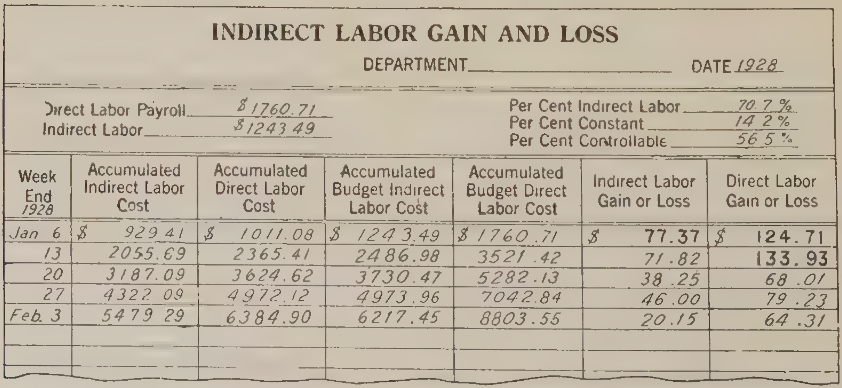
The steps in the budget preparation procedure are, then, as follows:

1. Split the production budget into operations in each department, and show the weekly production on each operation. Our route sheets showing the standard operations to be performed on individual styles are used as a key in making this analysis.

2. Compute average unit direct labor costs for the preceding budget period. These unit costs are used in determining the budgeted direct labor costs. Where the actual costs vary from the standard, and there is reason to believe that these costs will be down to standard when action on these items takes effect, the standard rather than the actual cost is used in determining the budgeted direct labor cost. The total direct labor for the budget is computed by multiplying the budgeted weekly production on the operation by the respective unit costs for each style or class of product.

3. Compute allowable indirect labor costs. This computation is made by two methods:

(*a*) In departments where standard indirect labor is expressed in per cent of direct labor, the standard indirect labor per cent multiplied by the budgeted direct labor equals the allowable indirect labor costs for the specified direct labor budget. This figure is used mainly as a guide setting the indirect labor budget plan.



INDIRECT LABOR GAIN AND LOSS

DEPARTMENT________ DATE 1928

Direct Labor Payroll $1760.71
Indirect Labor $1243 49

Per Cent Indirect Labor 70.7 %
Per Cent Constant 14 2 %
Per Cent Controllable 56 5 %

Week End 1928	Accumulated Indirect Labor Cost	Accumulated Direct Labor Cost	Accumulated Budget Indirect Labor Cost	Accumulated Budget Direct Labor Cost	Indirect Labor Gain or Loss	Direct Labor Gain or Loss
Jan 6	$ 929 41	$ 1011.08	$ 1243.49	$ 1760.71	$ **77.37**	$ **124.71**
13	2055.69	2365.41	2486.98	3521.42	71.82	**133.93**
20	3187.09	3624.62	3730.47	5282.13	38.25	68.01
27	4322 09	4972.12	4973.96	7042.84	46.00	79.23
Feb. 3	5479 29	6384.90	6217.45	8803.55	20.15	64.31

FIGURE 18. *This summary record sheet compares the factory payroll for direct and indirect labor with budgeted costs. Heavy figures show losses*

(*b*) In departments where standard indirect labor is expressed in cents per dozen of production, the desired figure for allowable indirect labor is computed by multiplying the budgeted production by the standard unit indirect labor costs. In setting the actual indirect labor budget plan, the budgeted cost must not exceed this figure.

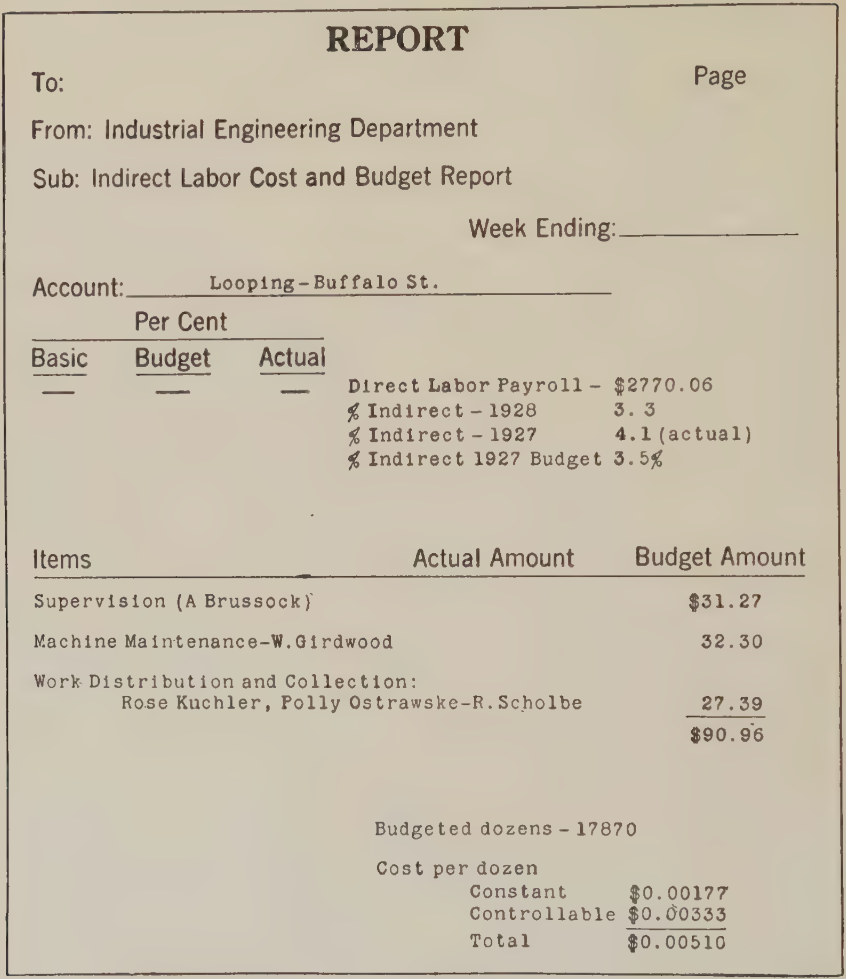
4. List all constant indirect labor items for each department. This classification of indirect labor consists of those expenses for salaried foremen and assistants which remain the same, regardless of production variations. These items do not fluctuate with variations in production, so they are eliminated immediately from the category of controllable indirect labor. While this cost item is included in all cost computations, for budget purposes we make this segregation before we lay open to severe scrutiny all other items. The constant items are deducted from the allowable indirect labor costs determined as shown in paragraph 3, and the remainder represents the limit within which all other indirect labor cost of a controllable nature must be confined.

5. In individual conference with department managers lay out the budget plan for the controllable indirect labor cost items. With all data in hand, a definite organization is made up of all the personnel needed to carry out the production budget. The rates of pay or salaries of each person are listed for the computation of the total cost of controllable indirect labor. If this total cost comes within the limits described in paragraph 4, the process is considered complete. On the other hand, should the total cost exceed the guide figure, the process is more involved.

It is then necessary for the department manager and the budget specialists to study all possibilities for reducing the costs in their plan, so as to make possible a budget acceptable for submission to approving authority. A re-alignment of personnel and their duties, a short cut in the indirect labor work of the department, or some other action, must be taken to achieve the desired goal.

6. Summarize departmental budgets into one complete factory labor expense budget. This step is primarily a synthetic process and shows what the total budget looks like, what its cost is, and what cost elements are most prominent.

7. Compare summarized budget with previous budget and actual cost for the preceding six months' budget period.



REPORT

To: Page

From: Industrial Engineering Department

Sub: Indirect Labor Cost and Budget Report

Week Ending: ____________

Account: Looping-Buffalo St.

Per Cent				
Basic	Budget	Actual		
—	—	—	Direct Labor Payroll -	$2770.06
			% Indirect - 1928	3. 3
			% Indirect - 1927	4.1 (actual)
			% Indirect 1927 Budget	3.5%

Items	Actual Amount	Budget Amount
Supervision (A Brussock)		$31.27
Machine Maintenance-W.Girdwood		32.30
Work Distribution and Collection: Rose Kuchler, Polly Ostrawske-R.Scholbe		27.39
		$90.96

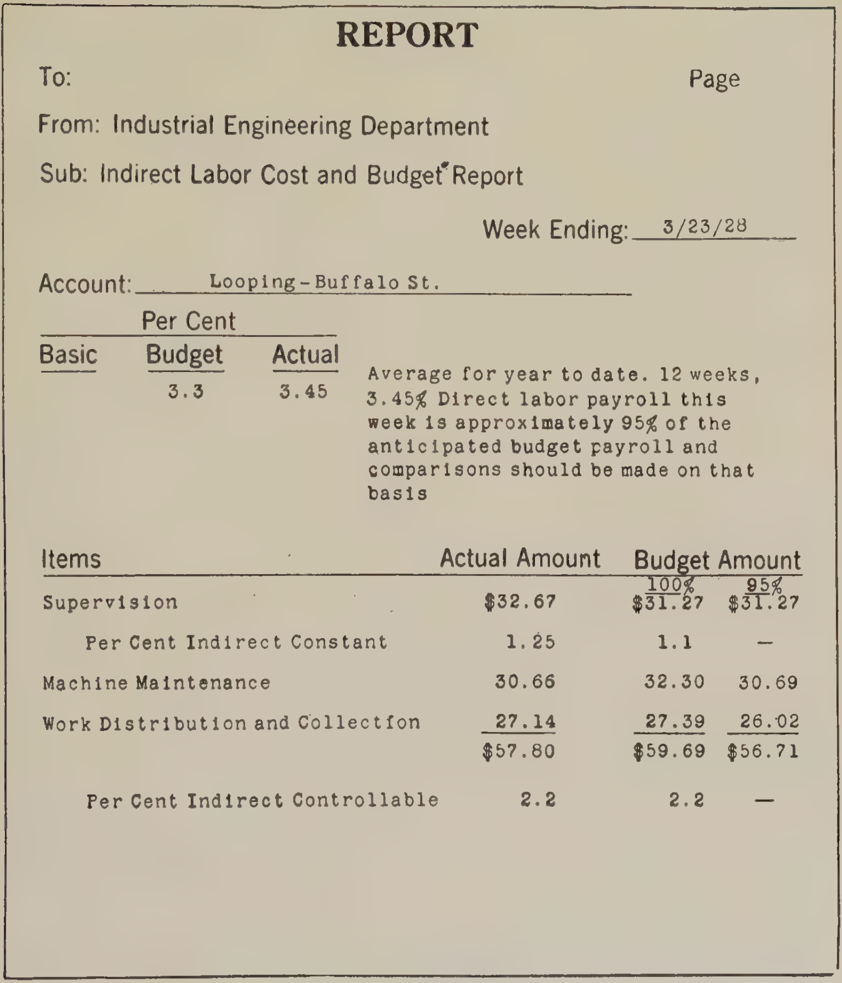
Budgeted dozens - 17870

Cost per dozen

Constant	$0.00177
Controllable	$0.00333
Total	$0.00510

FIGURE 19. *Sample budget sheet for typical department*

This comparison and summary of the factory cost budget make it possible for the manager to review the budget intelligently and to suggest revision or give approval. The factory budget, in order to be satisfactory for official management approval, must be so drawn up as to fit into the general budget without difficulty. All its items must correspond to the controlling accounts of the general ledger, permitting a ready audit of results during any part of the budget



REPORT

To: Page

From: Industrial Engineering Department

Sub: Indirect Labor Cost and Budget Report

Week Ending: 3/23/28

Account: Looping-Buffalo St.

	Per Cent	
Basic	Budget	Actual
	3.3	3.45

Average for year to date. 12 weeks, 3.45% Direct labor payroll this week is approximately 95% of the anticipated budget payroll and comparisons should be made on that basis

Items	Actual Amount	Budget Amount	
		100%	95%
Supervision	$32.67	$31.27	$31.27
Per Cent Indirect Constant	1.25	1.1	—
Machine Maintenance	30.66	32.30	30.69
Work Distribution and Collection	27.14	27.39	26.02
	$57.80	$59.69	$56.71
Per Cent Indirect Controllable	2.2	2.2	—

FIGURE 20. *This department is within its weekly budget*

period. Too much stress cannot be laid on this feature in formulating an effective budget plan.

OPERATING THE BUDGET

The major result to be expected from the operation of a budget system of controlling expenses comes from the follow-up work. Our budget of factory expenses is followed up and analyzed weekly, by the method formerly used for controlling costs on the basis of our standard cost system. The factory payroll is distributed to its respective cost accounts for direct and indirect labor. Figure 18 shows how this cost is recorded and variations from the budgeted cost expressed in terms of dollars lost or gained over the budget figure. The last two columns show an accumulation record of these gains or losses on each cost account, the heavy figures representing the red ink entries.

For summary purposes, the cards are consolidated on group cards for the department and the entire factory. It is then possible to see at a glance the accumulated gain or loss over the budget at any stage in the budget period, either for the entire factory or the individual department.

These summary cards save considerable time for those people who have to check up actual performance. When losses occur on the general factory budget card, further study of the departmental cards discloses the departments responsible for the losses. Still further investigation into the individual cost account cards of the departments reveal the style of product and operation on which the losses occur. Here it is possible to study the individual performance records and find out which operators require attention. The correction of the high cost condition can now be taken over by the foreman in charge of the department. Similar steps are followed in the analysis of high cost items in indirect labor.

To aid in securing the necessary corrective action on the part of the foreman, a plan of writing a report on the budget cost card analysis is carried out for each department. The sample forms shown in Figures 19 and 20 represent a budget of indirect labor for a typical department and a report of one week's operation during the budget period. This sample report shows a department that is running in line with the budget on its indirect labor expenses. As a result, no comments are necessary; however, space is provided on the form for all necessary description of cost items exceeding the budget. These descriptions are also accompanied by the necessary verbal data for inducing action of correction by foremen.

ENERGIZING THE FOLLOW-UP PLAN

To make the budget follow-up more effective and to insure actual performance within the limits of the cost budget, the personal interests of the foremen must be enlisted. This is done by making each foreman draw up his own expense budget, with the help of the budget specialist, who has available at his finger tips all data on past budgets, past performance, and standard costs. It is then possible to take the attitude toward the foreman that "You drew up this budget, and you certainly can operate within your own budget." The foreman feels his responsibility and acts accordingly. The spirit of "it can be done" can be planted and made to bear fruit.

A part of each foreman's total compensation is made to depend upon a financial incentive plan, under which the foreman receives a premium that increases in proportion to his success in achieving two objectives:

1. To reduce his budget below his former budgets;
2. To keep within this budget, or better still, to beat it.

The cost systems previously described make possible an accurate measurement of results of operation compared with standard costs. Operating gains or losses shown in the cost accounts for the department enter directly into the computation of the foreman's premium on a simple formula basis.

EVALUATION OF RESULTS

The evaluation of results coming from the application of any complicated management tool, however effective, involves many difficulties and dangers. The enthusiasm of the supporter of the improved management mechanism may cause an over-rating of its part in bringing about actual economies. Gradually improved conditions in factory operation are usually the composite result of a number of economy measures developed simultaneously.

Some tangible results of exercising intelligent control of factory expense through the budget can be stated, with the reservation that other activities have had some part in their production. When budgets were first established, the total indirect labor budget amounted to 34 per cent of the total factory direct labor payroll. After three years of operation, the budget for indirect labor amounts to 30 per cent of the direct labor payroll. On an annual direct labor payroll of approximately $1,500,000, this 4 per cent reduction on indirect labor represents a saving of $60,000 per year. This saving, effected during a period when business conditions have made necessary certain additions to indirect labor which were formerly unnecessary, would have been much greater without this attendant neutralizing condition.

The cost control and budget plan is, however, not a panacea. Rather it is an effective defensive management tool that prevents cost from rising. It can also be expected to effect low per cent savings in operating costs, though the revolutionary changes in manufacturing costs now found so necessary by all companies must still come from the application of the real offensive tools of management for cost-cutting, such as inventions in labor- and material-saving machines, research into materials, motion study, time study, and training of workmen in efficient work methods. When these tools have been applied, budgetary control becomes doubly effective.

OUR FACTORY HAS *ONLY ONE* CUSTOMER—THE SALES DEPARTMENT

By A. S. RODGERS

President, White Sewing Machine Company, Cleveland

OUR plant has only one customer: The sales department. The sales department places its order with the manufacturing department, well in advance of the required delivery date. The factory makes the goods as ordered, accepting modifications, cancellations and the like only to the extent that these would be acceptable from any outside customer. And if the sales department fails to dispose of the goods after it has ordered them—certainly the general management cannot hold the manufacturing executives responsible for building up an excessive inventory of finished goods on the strength of firm orders from their only customer.

It is not handled in any arbitrary fashion, of course. The two essential halves of the business, production and distribution, do not operate on a buck-passing basis. They work together in the hope of earning the largest consistent profit for the business as a whole, as well as for the individual departments. Naturally a plan such as we employ cannot make money for the company, except as it is operated along common-sense lines by department heads who would rather pull together than in opposite directions.

At the bottom, our plan is intended to make sure that credit goes where credit is due. In our observation, far too many companies operate in a manner which diverts all the blame into the factory yard and all the medals to the sales manager's glass-topped desk.

If the orders are not coming in and inventories pile up in stock rooms, it is all the plant's fault because the product is not up to the standard of competitors, or because the price is too high because of high production costs. If orders are rolling in by the mail sack full, this indicates that the sales department is marvelously capable; and obviously sales would be bigger yet if the plant would only turn out goods fast enough!

Our purpose is to get the sales department into the same situation as if it were a separate corporation, separately owned, that bought the finished product from the factory for cash. Under such an arrangement, a sales corporation does not get overstocked. At the same time, it places its orders with the factory far enough ahead to get prompt delivery. And if, perchance, the sales corporation makes mistakes in its anticipations it revises its commitments as quickly as possible so that smaller future orders will level off its inventories.

We have pretty well accomplished these results by our method of co-ordinating production and sales department activities. And like most methods of gearing up sales and production, ours starts with a budget. Like practically every budget which accomplishes this type of result, ours is not imposed from the top, but is developed to the joint satisfaction of the men in charge of manufacturing, of distribution and of the general management.

Cash position, profit and volume are the three major points we keep in mind in working out our budget. It starts with a commitment from the sales department on the number of units it will dispose of during the year. With the heads of the business sitting together, this aggregate is broken down into so many units of each model, which will be sold at specified prices. The plant executives agree to produce these finished products at a definite cost, and the sales executives to sell them at a definite expense.

These figures go to the accounting department for projection into the future. A 12-months' balance sheet is developed from the figures, showing our cash position and profits throughout. When this comes back to the management, we decide whether it is satisfactory. If not, we all sharpen our pencils and revise it until it attains the showing we feel we must have. If it is satisfactory, we accept it. The cash picture of month-by-month income and month-by-month disbursements, with the final profit showing, is what we gage it by.

Once the budget is accepted, it is turned over to the sales department to be broken down by territories, sales branches and so on.

After the first 30 days, incidentally, this is checked up. The sales department is held to its estimates—if it is found necessary to correct any variations, they are corrected immediately.

Our manufacturing schedule is three months; that is, it takes approximately three months for a piece of material to go through the manufacturing process from raw stock to finished stock. Therefore the sales department orders are placed with the manufacturing department three months ahead. On February 1 the order is placed for May delivery.

Each month the sales department has the opportunity to revise its orders.

While it cannot, of course, keep the plant from spending some material and time on the production of excess goods already ordered—assuming that sales are not holding up to plans—the monthly revision of orders makes it possible to catch any excess goods at the earliest possible moment, before they have any more than the bare minimum of money tied up in them.

It is much better sense, of course, to store steel bar stock than to store the screw machine parts made from this same tonnage of bars, or to store screw machine parts rather than finished product.

There is a direct financial penalty on the sales department, if as a result of its over-enthusiasm the factory produces a large advance stock. To explain how this works, it is necessary to go very sketchily into our sales compensation methods.

Our branch managers are paid on performance, taking into consideration how well their results—individually—check up with the advance plans of their respective branch jurisdictions.

A branch manager's additional compensation, or bonus, above his regular salary, is computed upon the basis of the gross profits earned by his individual branch in excess of a certain standard of performance, which includes a number of important factors.

However, the final rating of a branch manager's ability is based on net profits shown on the books at the home office, which of course is after all selling and administrative expenses have been deducted from the sales value, and from this gross figure is deducted the factory manufacturing cost of the goods.

If, then, the manufacturing department builds up an excessive inventory, the cost of the goods naturally increases. This in turn reduces the profit showings of the men responsible for the sales department, and affects their classification. It becomes of major importance to them to see that their orders to the factory are held at the point where they will yield the greatest returns to the company.

Under our arrangement, not all discretion as to manufacturing schedules is vested in the sales department. The sales department tells what goods it expects to need, ordering them.

Just how and when the plant turns these goods out, so long as they are ready when ordered, is the province of the plant executives. The production control division in the plant, in fact, has access to all sales figures.

Suppose that for a model which we shall call Number 1 the sales department has placed an order for 400, ordered December 1 for delivery February 1. During February, for some reason, only 250 units are sold. It is probable, in our experience, that the sales department through a shift in selling emphasis will have disposed of 150 extra units, above the production schedule, of Model Number 2.

Since a majority of our parts are interchangeable among many models, it is comparatively easy to shift over the factory schedule during the next months to produce the extra volume of Number 2. But if the sales department shows a complete disinclination to take off the factory shelves the 150 extra of Number 1, the plant executives are well within their rights if they refuse to step up the schedule of Number 2 until the surplus of Number 1 has been disposed of. Under these circumstances, if the sales department considers the factory unfair, it has the privilege of appealing to me for a ruling. By this time, however, somebody ordinarily gets busy and discovers some means of getting rid of the excess supply.

A usual complaint which is often heard in a line of business like ours is that the sales department is always agitating for a change of models, for changing this and changing that unnecessarily. This does not come up, under our plan. In the first place, the factory never makes a change without consulting the sales department and getting its approval. If it tried, it would be in exactly the situation of a manufacturer who changes a customer's specification without permission. Whenever a change of any sort is contemplated, it is talked over jointly by the management, the sales and the production groups.

The sales department knows, from the nature of its working arrangement with the factory, that when there is a change of models it will have so many of the old models to clear out before it can get its full force behind the new model. Under such circumstances a supply of old models is always awkward to sell. Ergo, sales requests for constantly changing models are automatically held to a minimum in our organization.

All of this has two principal results in our plant. First, we are able to hold manufacturing schedules to very nearly a dead level, with all of the benefits in steady personnel and lowered costs that this implies. Second—and even more significant,—we operate on an extremely low inventory. Our plant employs about 1,000 on the hourly or premium payroll. This fluctuates very little, which is certainly as it should be.

Instead of having the problem we used to groan under, that of breaking in a lot of new help a couple of times a year and then laying them off just about the time they got to be worth their salt, we now hold the same group of workers month after month. And the labor turnover which arises from the employees' side is lower because we are a more desirable outfit to work for than a company which lays off men frequently. Of course this steady employment of experienced men holds down our production costs. And the steady employment of plant facilities on an even schedule is a powerful influence in the right direction. The sales department cannot order 10,000 units one month, 7,500 the second and 12,000 the third. A variation between 9,500 and 10,000 might be accepted, but nothing wider except under emergency circumstances.

In 1921 we had an inventory of $4,000,000; we were doing about the same volume, in number of units, as today. In 1928 we have averaged $1,500,000 inventory, an average we have maintained since 1925. We released $2,500,000 of operating capital, and all of the floor space required for carrying this inventory. In 1921 we had 1,186,000 square feet; today we have 800,000 square feet. We sold a plant containing 276,000 square feet for almost $1,000,000 in cash. And it is costing us less to manufacture now than then because we are not spread over so much space and consequently have far less handling. We moved into this same area equipment from our Buffalo plant of 150,000 square feet by adding 40,000 to the 760,000 square feet we already had in Cleveland. We did away with all this maintenance, lighting, heating, taxes and insurance in the other plants by concentrating all in one plant. We got it all under the eyes of a single plant management. If you can figure out what this is worth to us in dollars, you are better informed about our business than I am! Obviously, though, it has been worth a great deal. It means the difference between operating at a profit maybe, and operating at a sure and substantial profit.

To be sure, a good deal of this saving has been accomplished through better management in the factory. But the bulk of the credit for it must go to the close co-ordination between the factory and sales departments, and the great reduction in inventory which this has made possible. Nowadays we are able to operate the plant with a definite assurance that what it is making is what is being sold, that the goods it is turning out will be converted into cash or into customers' paper almost in a continuous stream.

We have practically done away with losses from obsolescence and from injury to finished goods in stock. The slower your rate of turnover, the larger will be the losses through obsolescence, through damage, faulty manufacturing that needs reprocessing. Our cost for all this, per given unit, in 1921 was 70 cents. By 1925 we had this down to 15 cents. We attribute not all of this, but a considerable percentage, to our having smaller inventories.

Consider what is often not considered, the effect of large inventories of parts on the loss through faulty manufacturing. If parts flow in a steady stream from the machines, through inspection and into assembly, no defective goods will get very far. The real functional gage of production is in the assembly department—no matter how much and how carefully you inspect, the real test of your output is the answer to "Does it work?" We used to have trouble with this sort of error getting a long way into production, tying up lots of good money in defective parts which had to be reprocessed or even scrapped. No this does not happen. It has no chance to.

It is a little difficult for us to understand, as we look back now, how we ever got along with anything sort of the present close co-ordination between sales and production. The one gears naturally to the other; production cannot be conducted most efficiently unless it is intermeshed with sales.

Our sales executives and our plant executives work together with the utmost good will. Together they figure out far more good ways to cut expenses and increase profits than do we of the general management.

Our experience has convinced us that the one best way to increase profits is to get the two halves of the business to functioning as a whole. And the best way we have discovered for accomplishing this is by giving our factory just one customer, the sales department.

DAILY CONTROL OF PRODUCTION

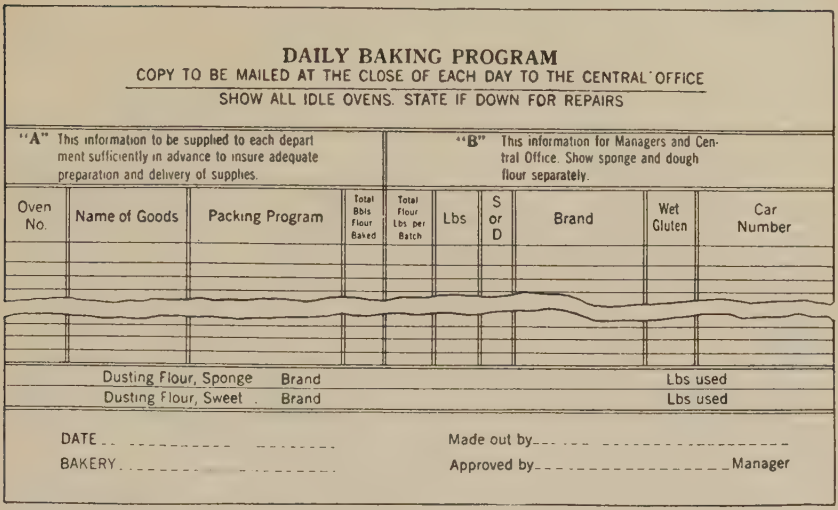
Loose-Wiles Biscuit Company Have Convenient and Effective Method of Scheduling Baking to Meet Each Day's Sales Demand

EVEN the best of equipment will not operate satisfactorily without production control. This condition is particularly the case in a bakery, whose products must be fresh when they reach the consumer. Production control in the Loose-Wiles bakeries is of two kinds—quality control exercised by the laboratory, and output control exercised by the manager, superintendent and heads of departments.

The laboratory of the Long Island City bakery of the company, located on the second floor, maintains physical and chemical control over production processes. All incoming materials are sampled and carefully analyzed to make sure that they are fresh, pure and up to the established standard. Temperatures and humidities under which certain operations must be performed have been measured and standardized. Baking times and temperatures have been carefully studied and correctly set. Formulas for the numerous kinds of biscuits and crackers produced and temperatures at which the ingredients must be mixed have undergone extensive research. Blending of spices and flavorings has also been thoroughly studied. Throughout all processes quantities have been exactly set. Quality control over manufacturing operations as well as over incoming materials is thus positively and completely established.

The system of production control used is as definite and extensive as the laboratory control over quality. A daily baking program is made out. (Figure 21.) Each morning at nine o'clock the heads of the various departments, the heads of the shipping department, a representative of the sales department, the superintendent and the suprintendent's clerk, meet to map out the following day's production.

This planning is thoroughly done. First, existing conditions are analyzed. The quantities of supplies on hand in the storeroom are,



DAILY BAKING PROGRAM

COPY TO BE MAILED AT THE CLOSE OF EACH DAY TO THE CENTRAL OFFICE

SHOW ALL IDLE OVENS. STATE IF DOWN FOR REPAIRS

"A" This information to be supplied to each department sufficiently in advance to insure adequate preparation and delivery of supplies.

"B" This information for Managers and Central Office. Show sponge and dough flour separately.

Oven No.	Name of Goods	Packing Program	Total Bbls Flour Baked	Total Flour Lbs per Batch	Lbs	S or D	Brand	Wet Gluten	Car Number

Dusting Flour, Sponge Brand Lbs used

Dusting Flour, Sweet Brand Lbs used

DATE

BAKERY

Made out by

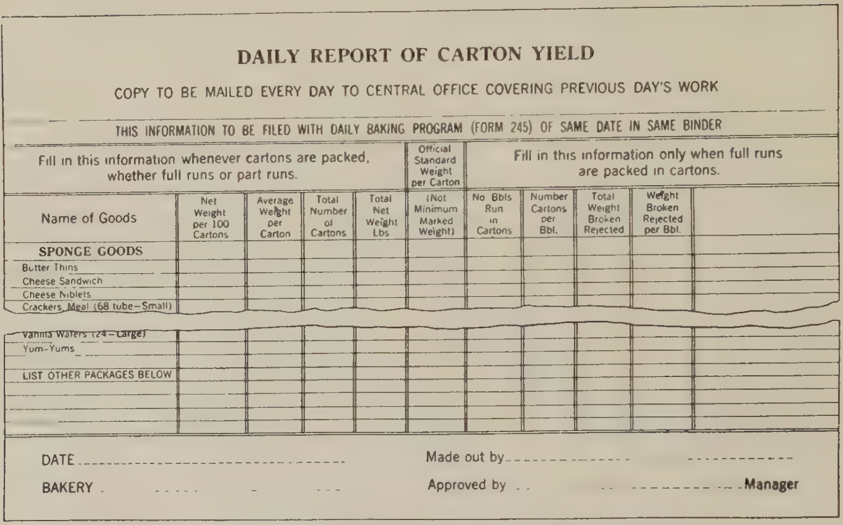
Approved by Manager

FIGURE 21. *Production schedule made out daily at conference*

of course, definitely known. Incoming shipments which are due in the immediate future are also on record. Each day the shipping department takes an actual physical inventory of the amount of finished goods on hand and this record is presented at the production conference. The amount of material in process is known from a report compiled by each manufacturing department at the close of the previous day's work.

The representative of the sales department makes a report on the kinds and quantities of products which must be shipped the next day to meet the needs of the distributing branches. In the case of the Long Island City plant, the territory to be covered extends from Canada to Florida, and from Stamford, Connecticut, to the middle of Ohio. The preparation of the sales report is therefore a very important task. From the statement of demand thus worked out the quantities of finished goods on hand and materials in process are subtracted. The differences show what the following day's baking program should be in order to meet the demand.

From extensive studies the capacity of each unit of baking equipment is known. Mixing operations preparatory to baking, and packing operations which follow baking, have been planned and organized to keep pace with the output of the baking equipment. It is therefore possible for the head of each department to tell at



DAILY REPORT OF CARTON YIELD

COPY TO BE MAILED EVERY DAY TO CENTRAL OFFICE COVERING PREVIOUS DAY'S WORK

THIS INFORMATION TO BE FILED WITH DAILY BAKING PROGRAM (FORM 245) OF SAME DATE IN SAME BINDER

Fill in this information whenever cartons are packed, whether full runs or part runs.					Official Standard Weight per Carton	Fill in this information only when full runs are packed in cartons.				
Name of Goods	Net Weight per 100 Cartons	Average Weight per Carton	Total Number of Cartons	Total Net Weight Lbs	(Not Minimum Marked Weight)	No Bbls Run in Cartons	Number Cartons per Bbl.	Total Weight Broken Rejected	Weight Broken Rejected per Bbl.	
SPONGE GOODS										
Butter Thins										
Cheese Sandwich										
Cheese Niblets										
Crackers, Meal (68 tube—Small)										
Vanilla Wafers (24—Large)										
Yum-Yums										
LIST OTHER PACKAGES BELOW										

DATE ------------------------------ Made out by ------------------------

BAKERY ------------------------------ Approved by ------------------------ Manager

FIGURE 22. *Report and check on carton yield and cracker breakage*

once whether the proposed program can be followed in his department, or whether it will be impossible to secure the desired output in one day. Where the quantity of any one kind of product required is not sufficient to keep any unit busy for an entire day, he can at once find out what other product can be put on this unit. It is customary to schedule each unit of equipment to handle a certain product either for a whole or a half-day run.

When all the required adjustments have been made in the baking program it is approved and each department head proceeds to lay his production plans for the following day. Sponge dough must be mixed up on the present day so that it can set for 18 hours before baking. Other products likewise require previous preparation.

Requisitions for materials for the following day's production are made out either by heads of departments, or by the superintendent's clerk. Production and operation studies have been made and records have been prepared showing the quantity ratios of materials and supplies which are required for the baking of each kind of product. These records show how many barrels of flour will be required to produce a certain quantity of crackers, allowing for breakage, how many cartons, caddies and tins will be needed, how much lining paper must be cut, and how many layer boards, labels, and wrappers must be furnished.

Requisitions for cartons, caddies and packing material, and for flour are usually made out by the superintendent's clerk, who obtains the required data from the records. Other materials are requisitioned largely by the heads of departments. These requisitions are sent at once to the stock room and are promptly filled during the afternoon. Dough which must rise for 18 hours is set in batches at intervals of every few minutes. Each batch has a number so that it will be put through the baking operations in correct sequence. When mixed it is taken into the rising room where it remains until early the next morning.

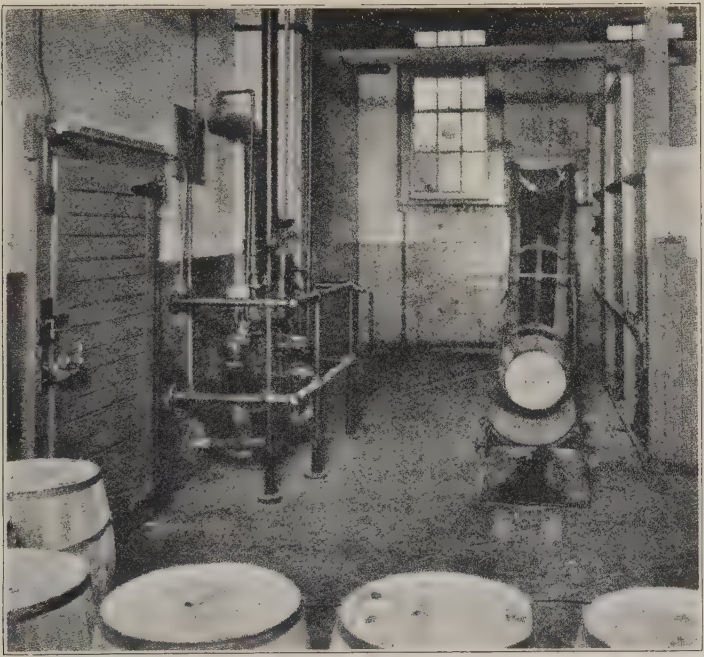


FIGURE 23. *Chute delivering incoming barrels of sugar to temporary storage. Refrigreated storage room at left*

A force of bakers comes to work at 2 a. m. each day. These men remove the batches of dough in regular order from the rising room, add the shortening, salt and extra flour and put the material through the second kneading operation so that it is ready for use when the baking machine and oven operators arrive.

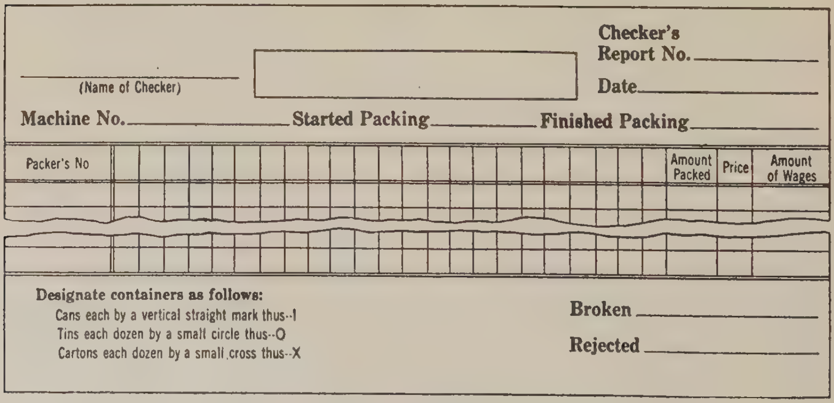
To further assist in scheduling production, the ovens in each department have been numbered.

Besides the daily baking program a number of other daily records are made out. One of these is a daily report of carton yield shown in Figure 22. On this report the average weight of cartons, total number of cartons, and total net weight of each kind of packaged product are given. For full runs a record of the number of barrels of flour used is made as a means of checking up with the standard yield. The weight of broken crackers is also recorded for checking against normal average breakage.

Similar daily records are made for the products packed in bulk. Another type of form is used for the sandwich machines manufacturing sugar wafers. The data tabulated include production, breakage, and any shutdowns which may have been necessary, with a statement of the causes. A daily manufacturing form is filled out showing the quantities of different grades of flour used, how the products made from these flours were packed—number of caddies, tins and cartons produced—and the quantity of crackers broken.

The icing department makes a special daily report showing the kinds and quantities of goods produced. A separate report is prepared by the fruit cake department.

Daily and weekly reports are prepared showing the amount of flour on hand and the amount in cars on the way to the bakery from the mills. All flour reports tabulate data according to different grades of flour. Records of grade, source and car number are noted



Checker's Report No.

(Name of Checker)

Date

Machine No. **Started Packing** **Finished Packing**

Packer's No	Amount Packed	Price	Amount of Wages

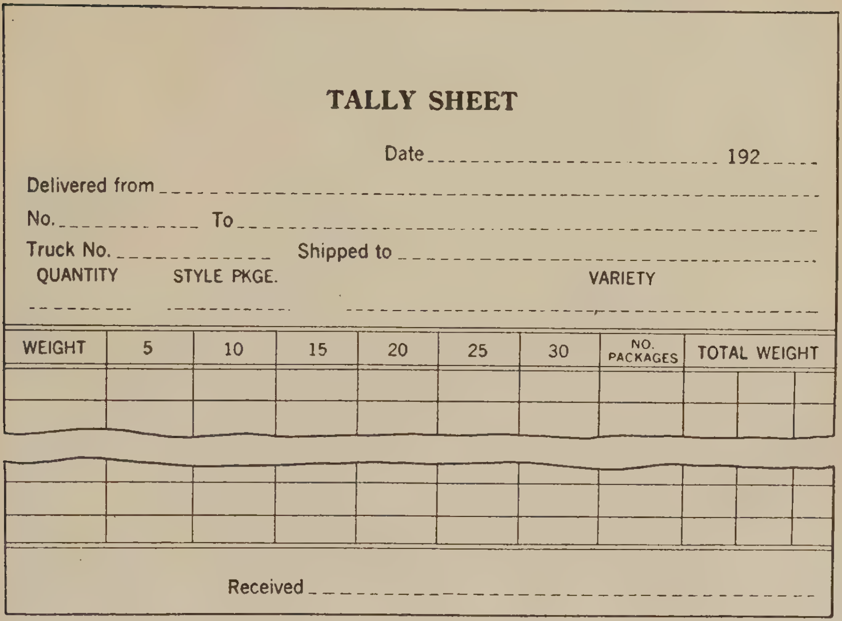
Designate containers as follows:

Cans each by a vertical straight mark thus--I
Tins each dozen by a small circle thus--O
Cartons each dozen by a small cross thus--X

Broken

Rejected

FIGURE 24. *Report on packing table operation*



TALLY SHEET

Date ____________________ 192____

Delivered from ____

No. ____________ To ____

Truck No. ____________ Shipped to ______________________________

QUANTITY	STYLE PKGE.	VARIETY
________	__________	______________________________

WEIGHT	5	10	15	20	25	30	NO. PACKAGES	TOTAL WEIGHT		

Received ____

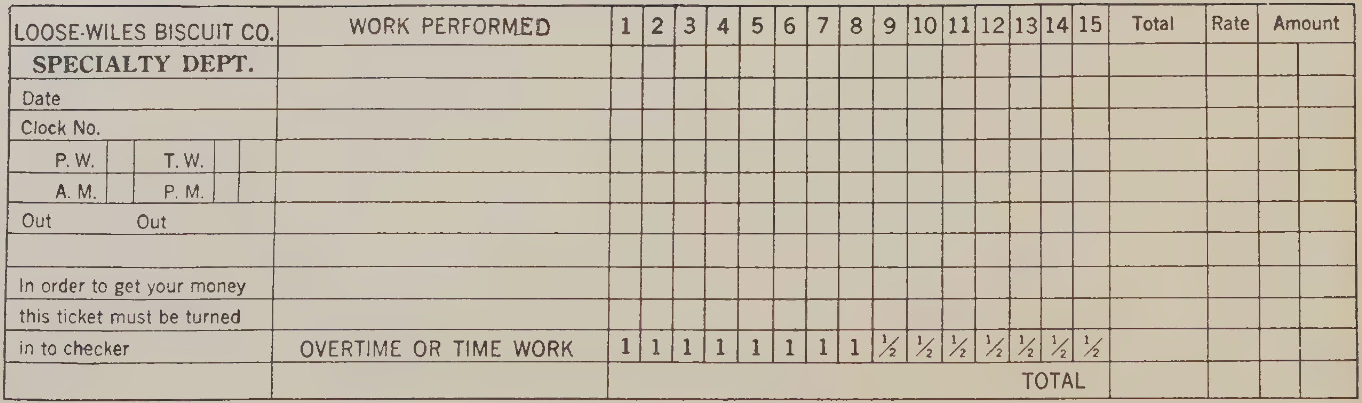
Figure 25. *Tally sheet for packages loaded on trucks*

on the various baking reports so that any trouble arising can be traced back to the actual lot of flour used in preparing the particular lot of crackers.

A daily machine report is made out for each department showing the time each baking machine starts and stops. Any shutdowns are noted, with the corresponding cause. This record shows the production turned out by each unit of equipment. A check of weights is also made daily on packages and a report of these weights tabulated.

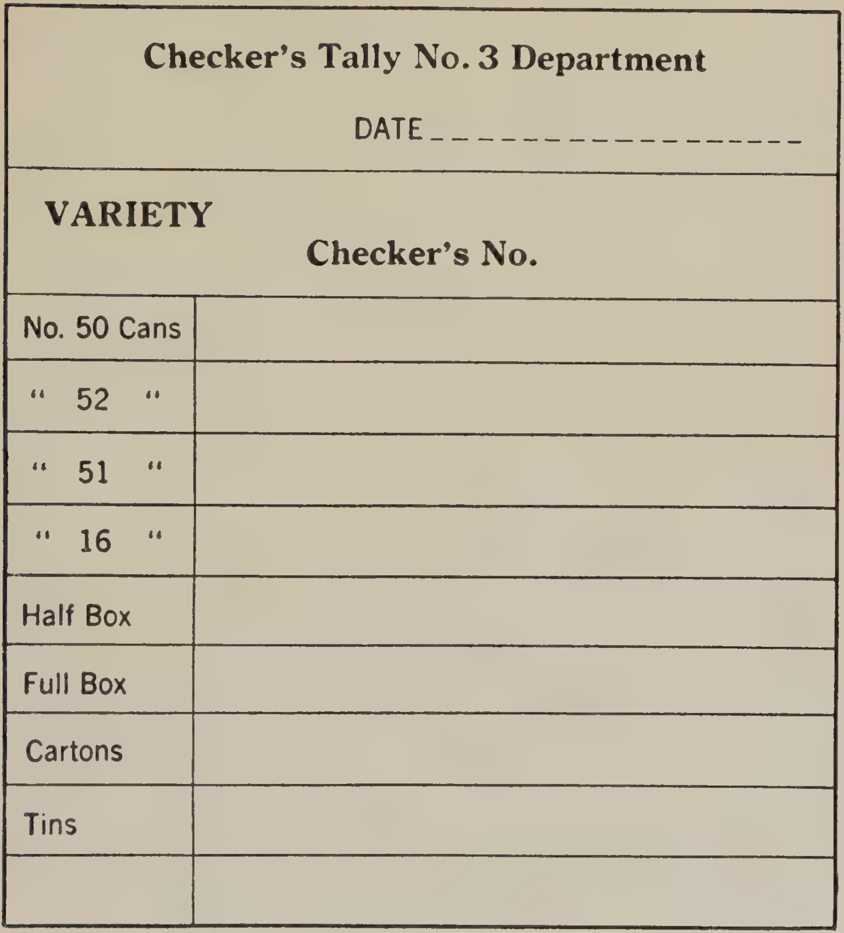
Daily records are also prepared by the packing department for each packing table. (See Figure 24.) When products are ready for loading on shipping trucks a tally sheet, Figure 25, is made out, listing the weights of the bundles of packages, or of the caddies, as the case may be.

From the records thus obtained various charts are prepared to check the operation of the departments in the bakery. Among the items charted are weights of broken and rejected crackers, yield per barrel of flour, and normal carton weight.



LOOSE-WILES BISCUIT CO.	WORK PERFORMED	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total	Rate	Amount
SPECIALTY DEPT.																			
Date																			
Clock No.																			
P. W. T. W.																			
A. M. P. M.																			
Out Out																			
In order to get your money																			
this ticket must be turned																			
in to checker	OVERTIME OR TIME WORK	1	1	1	1	1	1	1	1	½	½	½	½	½	½	½			
		TOTAL																	

Figure 26. *Work ticket for individual operators on the packing tables*



Checker's Tally No. 3 Department

DATE_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

VARIETY	**Checker's No.**
No. 50 Cans	
" 52 "	
" 51 "	
" 16 "	
Half Box	
Full Box	
Cartons	
Tins	

FIGURE 27. *Independent tally to check summary from individual work ticket*

The piece-work wage payment system has been adopted as the most suitable for workers in the production, packing and shipping departments. Flow of work is practically steady and the product is handled in units which are easily checked. Wage rates for work on the different kinds of biscuits and crackers made have been adjusted so that due allowances are made where operations are difficult and necessarily slow. (Figures 26 and 27.)

While a great deal of data is obtained from the daily reports previously described, which are summarized monthly, and in some cases weekly, a better basis is necessary for control over costs. From time to time test runs are made on the equipment. These tests cover all kinds of crackers and biscuits produced. Quantities of materials, labor, overhead, and all items necessary for complete cost accounting are carefully recorded. From the figures thus compiled an actual unit cost is worked out for each kind of product.

This check-up serves to show whether costs are relatively at the standard, or are increasing or decreasing. It points out places where studies must be made to reduce expenses by improving equipment or introducing methods to increase production. A further useful purpose is served to the setting of prices. When a new kind of product is to be made the cost records of a similar product already under production are investigated. From these figures it is possible to estimate very closely the cost of production of the new item. The necessary selling price can then be correctly established, or, if there is a general market price on some particular line of package goods, the amount to put in each package can be ascertained.

The shipping department controls products from the time they leave the manufacturing departments until they are loaded on cars or trucks for distribution. The two shipping rooms are laid out by a series of letters and numbers and package and bulk products are arranged in alphabetical order. A blackboard is used on which to enter truck numbers of each kind of goods in the order that they arrive so that they can be shipped in the same order. Bulk goods carry date numbers to further make sure that products are moved out in the same order as received.

Carload and less-than-carload shipments for out-of-town distribution branches are made up during the day. The loaded freight cars are removed twice daily and replaced by cars containing incoming materials. Metropolitan and occasionally more distant deliveries are made by motor truck. Orders received up to 7 o'clock each evening are loaded on trucks during the night. The goods are billed and manifested and the loads are all ready at the bakery for the early morning start.

All loading is done under cover. Assemblies of carload and less-than-carload lots are made on the piece-work basis. Before each car is filled it is thoroughly cleaned and lined with paper. The sides of the doors are sealed with tar paper. Considerable care is exercised in bracing the containers so that they will not become damaged and so that crackers will not break during transit.

A CO-ORDINATED PRODUCTION CONTROL PLAN

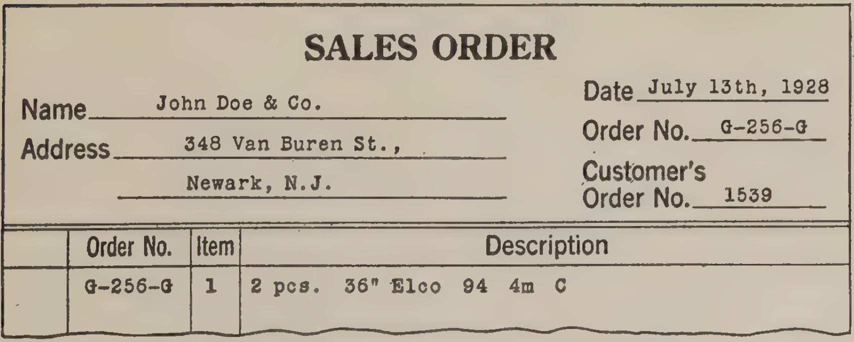
By GEORGE W. GREGORY
General Purchasing Agent, The Keratol Company

THE relative position of the purchasing department in any organization depends not only upon the type of industry, but also upon the attitude of the management. Centralized purchasing has long been accepted as the only economical method to be followed by large organizations, both commercial and industrial.

In the Keratol Company the purchasing department has been centralized not only in regard to buying, but also for sales and production co-ordination. This arrangement means that all sales orders or commitments are analyzed for requirements in the form of raw materials, and a perpetual inventory control is maintained. Production records show the actual withdrawals by the manufacturing division.

To maintain such a system it is absolutely necessary to have all records posted up to date daily, and balances shown. Otherwise it is impossible to make the system effective to the extent intended when it was planned. All raw materials are, of course, standardized irrespective of their nature, and are purchased subject to meeting certain specifications prior to being placed in stock. Only such materials as have been passed are placed in the active inventory control records.

The customer's order is received in the sales department and is rewritten to state in factory terms just what is to be produced. Figure 28 is a sample of such an order. Eight copies are made and distributed, the customer receiving the original as an acknowledgment,



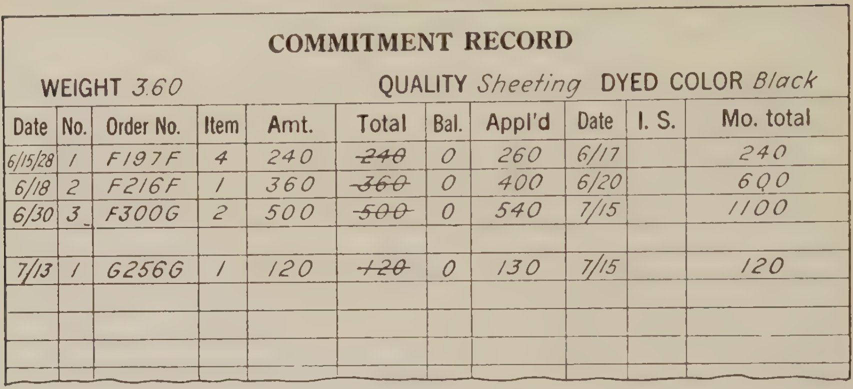
SALES ORDER

Name John Doe & Co.
Address 348 Van Buren St.,
Newark, N.J.

Date July 13th, 1928
Order No. G-256-G
Customer's Order No. 1539

	Order No.	Item	Description
	G-256-G	1	2 pcs. 36" Elco 94 4m C

FIGURE 28. *The program begins with a sales order*



COMMITMENT RECORD

WEIGHT 360 QUALITY Sheeting DYED COLOR Black

Date	No.	Order No.	Item	Amt.	Total	Bal.	Appl'd	Date	I. S.	Mo. total
6/15/28	1	F197F	4	240	~~240~~	0	260	6/17		240
6/18	2	F216F	1	360	~~360~~	0	400	6/20		600
6/30	3	F300G	2	500	~~500~~	0	540	7/15		1100
7/13	1	G256G	1	120	~~120~~	0	130	7/15		120

FIGURE 29. *Orders are entered on commitment records*

the sales department one copy, the factory three copies, the shipping department one, the files one, and the purchasing department the remaining copy. Detail formulas are in the hands of the purchasing department, itemizing the various raw materials required for manufacture.

The order as received by the purchasing department is broken down as follows:

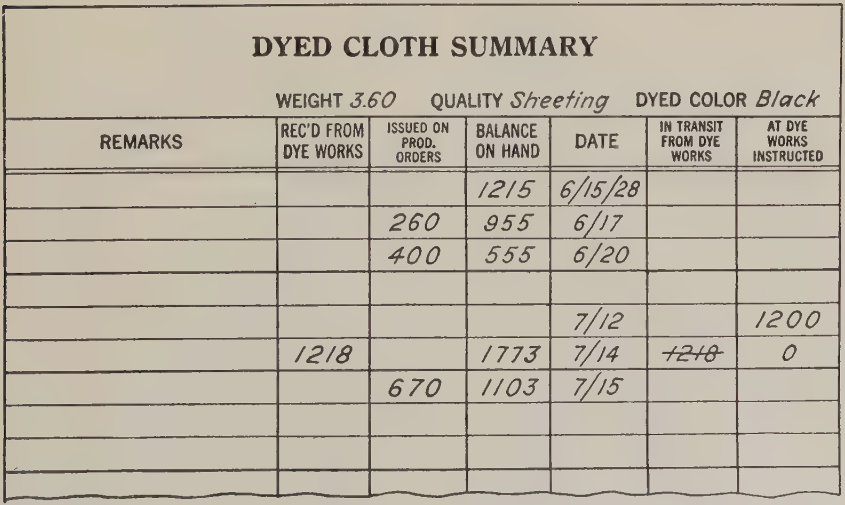
The customer's name, John Doe & Co., is of interest for possible future reference to sales. In the sales order number, G-256-G the first letter denotes the particular month in which the order is written or accepted, the letters A to M with I eliminated being used for months in even years, and N to Z with O eliminated for months in odd years. The number indicates the numerical sequence of the order for the month. The letter following denotes the month in which the order is to be filled and shipped. Thus G-256-G indicates the 256th order received in July, and it is to be filled and shipped in July. G-257-H would indicate the 257th order received in July and to be shipped in August. The entry next is the item number, which is always noted whether one item or a dozen are contained in the order. The number of pieces or yards ordered, is also shown, followed by the width, in this case 36 inches. A standard piece contains 60 yards. The quality, such as Elco, has a standard formula, and takes a specific kind of cloth. The number 94 is a color number which in this case happens to be black. The number 4 is the finish; letter "m" gives the pliability, medium, and the "C" is the grain in which the customer wishes the goods embossed.

We find that this order requires 120 yards of 40-inch 3.60 sheeting dyed black, so it is posted on the commitment record for this quality and color. All other orders except those marked "fill from stock" are broken down in the same manner, and commitments on all qualities and colors are posted in their respective places. (Figure 29.) It is then possible to analyze how much of each raw material is necessary for production, not only for immediate needs, but for future requirements.

A corresponding record is kept of all dyed cloth, which shows stock on hand at any given date, segregated by quality and color. (Figure 30.)

All cotton piece goods are purchased in the grey and are held in grey goods subject to dyeing instructions as required. A grey goods ledger (Figure 31) is maintained showing the number of bales on hand, bale numbers, yards of each bale, and disposition of any given quality. In conjunction with this ledger a summary book is kept (Figure 32), which shows total yards of each quality of grey goods stock on hand at any given time.

When orders are issued to dye grey goods stock in any given standard or special shade, disposition is recorded against the particular bale on the grey goods ledger sheet, Figure 31, and actual detail of dyeing is posted on a sheet in the dyed goods ledger cover-

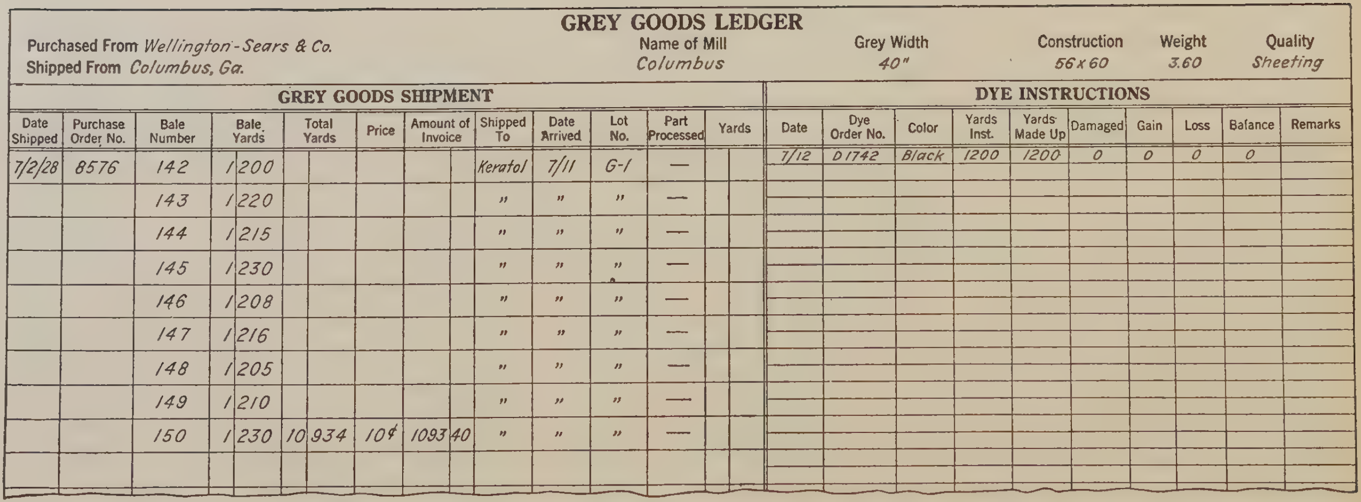


DYED CLOTH SUMMARY

WEIGHT 3.60 QUALITY Sheeting DYED COLOR Black

REMARKS	REC'D FROM DYE WORKS	ISSUED ON PROD. ORDERS	BALANCE ON HAND	DATE	IN TRANSIT FROM DYE WORKS	AT DYE WORKS INSTRUCTED
			1215	6/15/28		
		260	955	6/17		
		400	555	6/20		
				7/12		1200
	1218		1773	7/14	~~1218~~	0
		670	1103	7/15		

FIGURE 30. *Dyed cloth is recorded on a summary sheet*



GREY GOODS LEDGER

Purchased From *Wellington-Sears & Co.*
Shipped From *Columbus, Ga.*

Name of Mill	Grey Width	Construction	Weight	Quality
Columbus	*40"*	*56x60*	*3.60*	*Sheeting*

GREY GOODS SHIPMENT													DYE INSTRUCTIONS									
Date Shipped	Purchase Order No.	Bale Number	Bale Yards	Total Yards	Price	Amount of Invoice	Shipped To	Date Arrived	Lot No.	Part Processed	Yards	Date	Dye Order No.	Color	Yards Inst.	Yards Made Up	Damaged	Gain	Loss	Balance	Remarks
7/2/28	8576	142	1 200				Keratol	7/11	G-1	—		7/12	D1742	Black	1200	1200	0	0	0	0	
		143	1 220				"	"	"	—											
		144	1 215				"	"	"	—											
		145	1 230				"	"	"	—											
		146	1 208				"	"	"	—											
		147	1 216				"	"	"	—											
		148	1 205				"	"	"	—											
		149	1 210				"	"	"	—											
		150	1 230	10 934	10¢	1093 40	"	"	"	—											

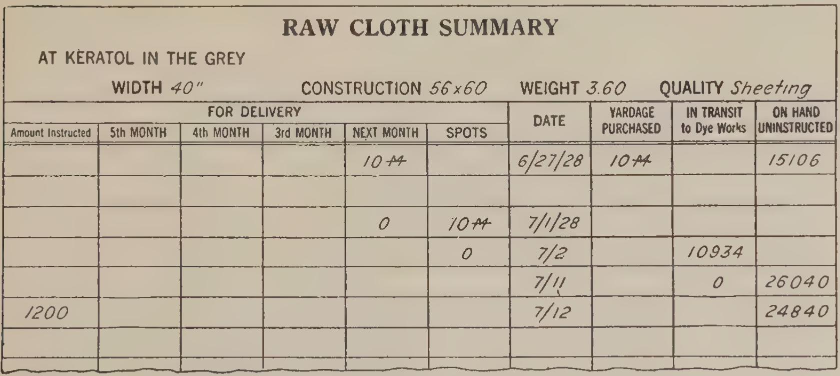
FIGURE 31. *A grey goods ledger controls the purchasing of cotton cloth and shows shipments and dye instructions*

ing that quality and color. A dyed goods ledger sheet is shown in Figure 33.

The method used in co-ordinating sales commitments with factory requirements is to establish certain maximums and minimums on dyed cloth, these depending upon the respective qualities. In most cases there is no maximum, as will be noted later, but the standard amount to have on hand at all times is considered the capacity in yards of that given quality which one dye jig can handle in one run. On light-weight fabrics this will run as high as 1,800 yards, whereas in heavy-weight goods it may be only 300 yards. The minimum amount is any part of such a bale, or even zero, depending upon the sales activity in that standard or color.

Having thus set up stock standard for factory requirements (Figure 30) it is necessary to determine what has to be made.

All sales orders, as shown in Figure 28, are analyzed and posted on Figure 29, showing date, order number, item number, and amount in yards sold. This amount is added to the previous total, or balance, as the case may be, and a new total arrived at. Whenever this total exceeds the total shown of the same quality and color in dyed stock, orders are issued to dye grey goods. Under no consideration are grey goods dyed when the dyed stock of any respective quality on hand exceeds the amount sold. The amount to be dyed is determined by the yards required to make the run as called for on customer's order, if it is special. To make the system perpetual, it



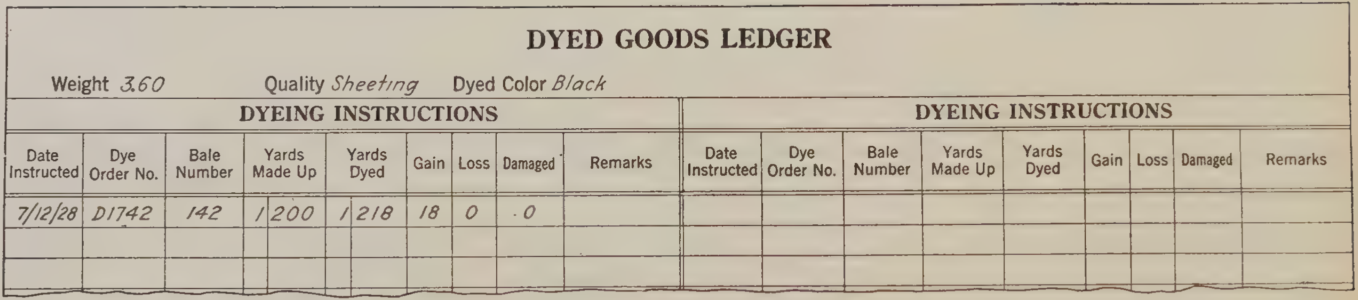
RAW CLOTH SUMMARY

AT KERATOL IN THE GREY

WIDTH 40" CONSTRUCTION 56x60 WEIGHT 3.60 QUALITY Sheeting

FOR DELIVERY						DATE	YARDAGE PURCHASED	IN TRANSIT to Dye Works	ON HAND UNINSTRUCTED
Amount Instructed	5th MONTH	4th MONTH	3rd MONTH	NEXT MONTH	SPOTS				
				1044		6/27/28	1044		15106
				0	1044	7/1/28			
					0	7/2		10934	
						7/11		0	26040
1200						7/12			24840

FIGURE 32. *In conjunction with grey goods ledger a raw cloth summary sheet is kept to show stock on hand*

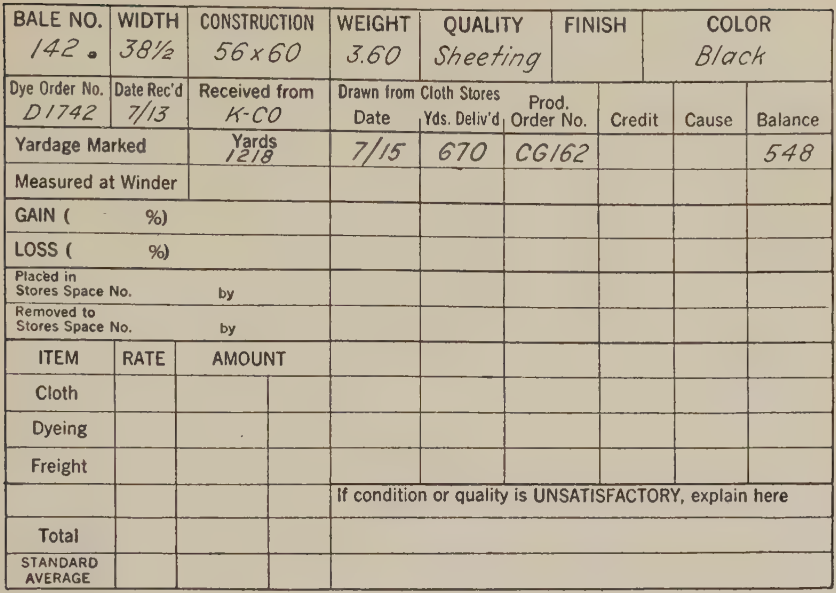


DYED GOODS LEDGER

Weight *3.60* Quality *Sheeting* Dyed Color *Black*

DYEING INSTRUCTIONS									DYEING INSTRUCTIONS								
Date Instructed	Dye Order No.	Bale Number	Yards Made Up	Yards Dyed	Gain	Loss	Damaged	Remarks	Date Instructed	Dye Order No.	Bale Number	Yards Made Up	Yards Dyed	Gain	Loss	Damaged	Remarks
7/12/28	D1742	142	1 200	1 218	18	0	0										

FIGURE 33. *A record of the dyeing work is posted to a dyed goods ledger sheet*



BALE NO.	WIDTH	CONSTRUCTION	WEIGHT	QUALITY	FINISH	COLOR
142	38½	56x60	3.60	Sheeting		Black

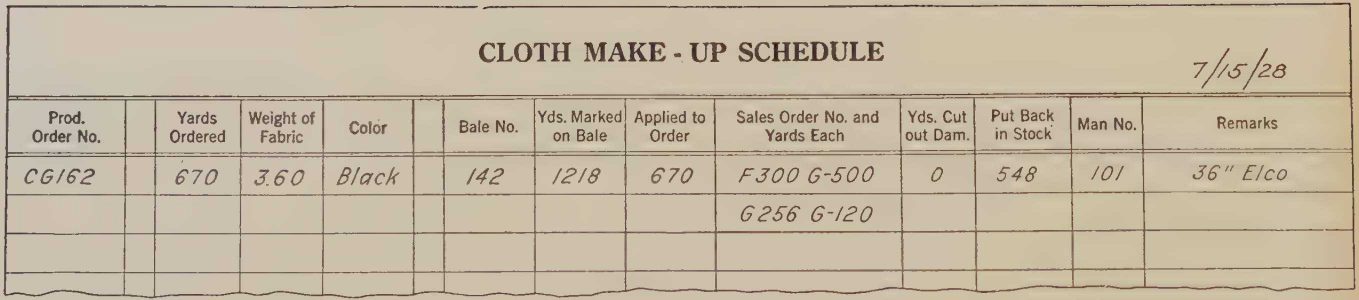
Dye Order No. D1742	Date Rec'd 7/13	Received from K-CO		Drawn from Cloth Stores Date	Yds. Deliv'd	Prod. Order No.	Credit	Cause	Balance
Yardage Marked		Yards 1218		7/15	670	CG162			548
Measured at Winder									
GAIN (%)									
LOSS (%)									
Placed in Stores Space No.		by							
Removed to Stores Space No.		by							
ITEM	RATE	AMOUNT							
Cloth									
Dyeing									
Freight									
				If condition or quality is UNSATISFACTORY, explain here					
Total									
STANDARD AVERAGE									

FIGURE 34. *A bale ticket identifies the dyed cloth*

is necessary to have factory production detail. This information is obtained as follows:

When grey goods are dyed there is a bale ticket made out in triplicate (Figure 34). The original is sent to the factory control office and kept in the file under the quality and color; the second or tissue copy is forwarded to the purchasing department with the duplicate of the dye order, and the third or triplicate copy is a bannerette of linen and paper which is attached to the bale of cloth. This bale ticket gives all details such as bale number, weight of fabric, color and finish, yards contained in the bale, the dye order number it was dyed against, and the date dyed. Space is provided for posting all withdrawals, and noting new balances.

The factory control office makes a master production schedule, which is split up into department schedules. One of these schedules is dyed cloth make-up (Figure 35) on which is shown production order number, yards required, the bale number from which it is to be taken, the quality of cloth, color, and the sales order to which it is to be applied. If the goods are to be applied to more than one sales order, the yards for each is designated.



CLOTH MAKE - UP SCHEDULE

7/15/28

Prod. Order No.		Yards Ordered	Weight of Fabric	Color		Bale No.	Yds. Marked on Bale	Applied to Order	Sales Order No. and Yards Each	Yds. Cut out Dam.	Put Back in Stock	Man No.	Remarks
CG162		670	3.60	Black		142	1218	670	F300 G-500	0	548	101	36" Elco
									G256 G-120				

FIGURE 35. *The master production schedule is split into department schedules, one of which is for dyed cloth make-up*

After all withdrawals have been made and the data posted on the dyed goods make-up schedule, a copy is forwarded daily to the purchasing department. This is broken down on a work sheet, itemizing all withdrawals of a like quality and color in yards, with the details of sales orders to which allotted. The respective amounts are posted against entries on Figure 29 and a deduction made of the lump sum, so that a new balance is obtained on commitments. If all allotments are in order in regard to amount withdrawn, the total amount of each quality and color is deducted from stock on hand on Figure 30. If only part of a bale is taken from stock, the amount withdrawn is noted on the bale ticket attached to the goods, and in the factory control office. This enables an inventory or check to be readily made, as a new balance is noted and the bale is still in active stock.

On other raw materials, outside of cloth, the amount required for production is maintained through the medium of set maximums and minimums, established by check of past consumption over a period of time, as well as our capacity to make up coating material. Sources of supply have been checked and standards established. The time required to obtain each material is a known factor. The minimum is figured as the quantity necessary to carry on production from the time the material is ordered to the time it is delivered, if the plant were running at full capacity.

All factory detail of withdrawals on raw material for make-up are forwarded daily to the purchasing department, and each individual product is segregated and totaled. This amount is deducted from the amount shown on hand on commodity cards, and a new balance shown. All incoming materials are reported and added to balances, thereby establishing a new total on hand.

The ordering and maintaining of all coating material stocks is placed absolutely in the hands of the purchasing department. To insure the correctness of records, all actual factory production forms are checked by the raw materials control clerk, from the first step—preparation of pigments, oil, and collodion—through the make-up of all base colors, blends of oil colors and standard stock daub, amounts of make-up oil colors and stock daubs on hand, and the amounts withdrawn for coating.

After made-up daubs are withdrawn the respective barrels are allotted to certain production coating orders, as shown on a coating schedule, and from this schedule there is made a coating analysis sheet, which is sent to the purchasing department and shows the amounts received, weight coated, and weight returned to make-up room. This entire sheet is broken down, and actual amounts of the various types of daub used are calculated and posted accordingly. This procedure maintains actual and active inventory control to a very close margin.

From these daily records a chart is kept showing pounds per machine coated and machine-tour records. Daily reports and details are, of course, compiled and a résumé made each week to be forwarded to the general manager.

KEEP YOUR FINGER ON PRODUCTION PROGRESS

By J. A. MADIGAN

Production Office Manager, Automatic Electric, Incorporated, Chicago

MODERN office equipment we find to be of great value in lightening the work of the production office. Take the routine of putting an assembly order through the production office. Five different types of labor-saving machines serve us in this connection: a billing machine is used in making out the stock list; a bookkeeping machine serves on the work in progress cards; a punched tabulating machine card does duty on the time cards; and a duplicating machine of the gelatin type makes out seven different forms used in the procedure. Then there is the common computing machine used for checking purposes.

Without going into a great amount of detail let us see how a manufacturing order is handled. A general picture of the procedure is given by a glance at the chart in Figure 36, which presents an outline of an order going through the production office.

In the first place, let me explain that we make very little to stock. The finished product is ordered by the engineering department which gives us typed specifications showing the complete unit. But because an order is placed by the engineering department for a given amount of product, it does not follow that this will be executed by the factory in one lot nor does it even mean that it will all be started into work. It is left to the planning department to determine what percentage of the order will be put through from time to time.

Of course the tendency with a new man is to put everything into the works, but in keeping with the times we try to hold the inventory down wherever possible. We endeavor to operate on the basis of a

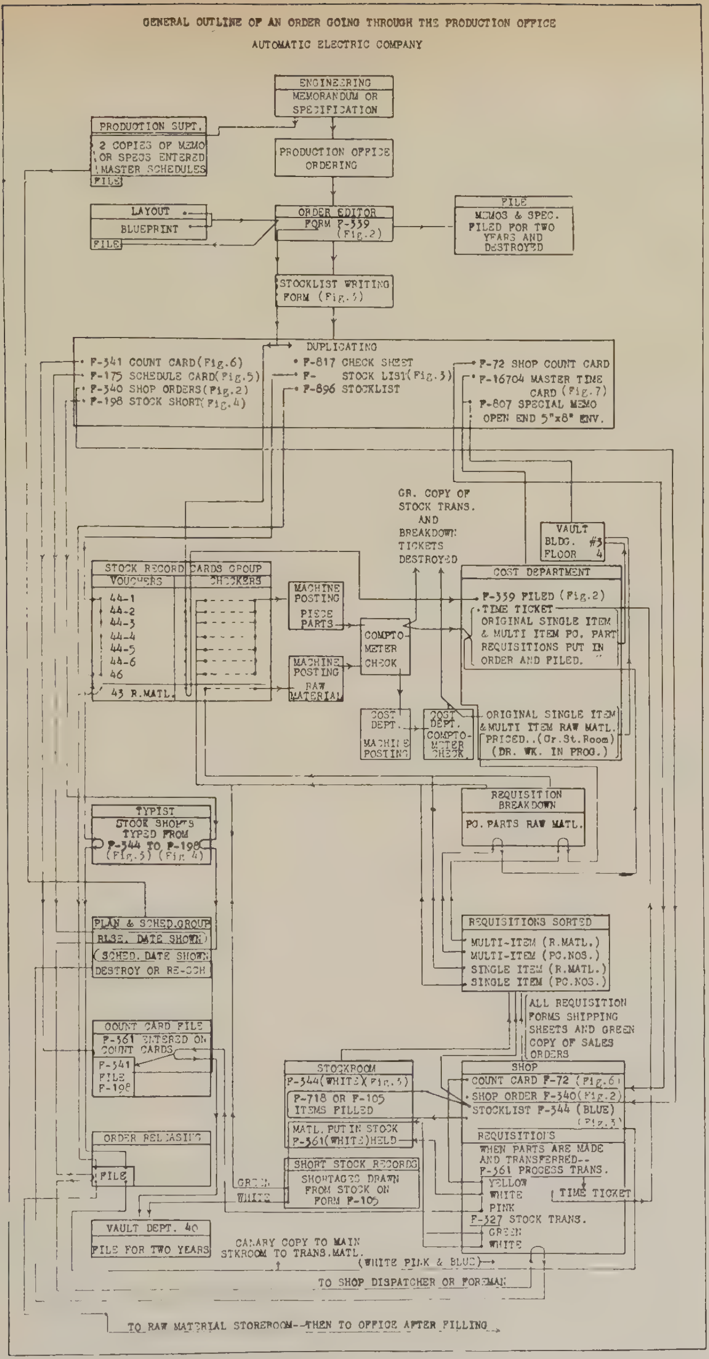

GENERAL OUTLINE OF AN ORDER GOING THROUGH THE PRODUCTION OFFICE
AUTOMATIC ELECTRIC COMPANY
ENGINEERING MEMORANDUM OR SPECIFICATION
PRODUCTION SUPT.
2 COPIES OF MEMO OR SPECS ENTERED MASTER SCHEDULES
FILE
PRODUCTION OFFICE ORDERING
LAYOUT
BLUEPRINT
FILE
ORDER EDITOR FORM P-339 (Fig.2)
FILE
MEMOS & SPEC. FILED FOR TWO YEARS AND DESTROYED
STOCKLIST WRITING FORM (Fig.3)
DUPLICATING
• P-341 COUNT CARD (Fig.6)
• P-175 SCHEDULE CARD (Fig.5)
• P-340 SHOP ORDERS (Fig.2)
• P-198 STOCK SHORT (Fig.4)
• P-817 CHECK SHEET
• P- STOCK LIST (Fig.3)
• P-896 STOCKLIST
• P-72 SHOP COUNT CARD
• P-16704 MASTER TIME CARD (Fig.7)
• P-807 SPECIAL MEMO OPEN END 5"x8" ENV.
GR. COPY OF STOCK TRANS. AND BREAKDOWN TICKETS DESTROYED
VAULT BLDG. #3 FLOOR 4
STOCK RECORD VOUCHERS
44-1
44-2
44-3
44-4
44-5
44-6
46
43 R.MATL.
CARDS GROUP CHECKERS
MACHINE POSTING PIECE PARTS
MACHINE POSTING RAW MATERIAL
COMPTOMETER CHECK
COST DEPARTMENT
P-339 FILED (Fig.2)
TIME TICKET
ORIGINAL SINGLE ITEM & MULTI ITEM PO. PART REQUISITIONS PUT IN ORDER AND FILED.
COST DEPT. MACHINE POSTING
COST DEPT. COMPTOMETER CHECK
ORIGINAL SINGLE ITEM & MULTI ITEM RAW MATL. PRICED. (Gr. St. Room) (DR. WK. IN PROG.)
REQUISITION BREAK DOWN
PO. PARTS RAW MATL.
TYPIST
STOCK SHORTS TYPED FROM P-344 TO P-198 (Fig.3) (Fig. 4)
PLAN & SCHED. GROUP
RLSE. DATE SHOWN
SCHED. DATE SHOWN
DESTROY OR RE-SCH
REQUISITIONS SORTED
MULTI-ITEM (R.MATL.)
MULTI-ITEM (PC.NOS.)
SINGLE ITEM (R.MATL.)
SINGLE ITEM (PC.NOS.)
ALL REQUISITION FORMS SHIPPING SHEETS AND GREEN COPY OF SALES ORDERS
COUNT CARD FILE
P-361 ENTERED ON COUNT CARDS
P-341 FILE
P-198
STOCKROOM
P-344 (WHITE) (Fig.3)
P-718 OR P-105 ITEMS FILLED
MATL. PUT IN STOCK P-361 (WHITE) HELD
SHORT STOCK RECORDS
SHORTAGES DRAWN FROM STOCK ON FORM P-105
GREEN
WHITE
SHOP
COUNT CARD P-72 (Fig.6)
SHOP ORDER P-340 (Fig.2)
STOCKLIST P-344 (BLUE) (Fig.3)
REQUISITIONS
WHEN PARTS ARE MADE AND TRANSFERRED--
P-361 PROCESS TRANS.
YELLOW
WHITE
PINK
TIME TICKET
P-327 STOCK TRANS.
GREEN
WHITE
ORDER RELEASING
FILE
VAULT DEPT. 40
FILE FOR TWO YEARS
CANARY COPY TO MAIN STKROOM TO TRANS.MATL.
(WHITE PINK & BLUE)
TO SHOP DISPATCHER OR FOREMAN
TO RAW MATERIAL STOREROOM--THEN TO OFFICE AFTER FILLING

FIGURE 36. *Here, in visual form, is the routine of a manufacturing order as it passes through the production office. Five different types of labor-saving hasten the procedure and keep costs at a minimum*

three months' supply. At least that is what we shoot at. And in the case of the ordinary raw materials we aim to keep one week's to a month's supply on hand, depending upon the location of the source.

In other words, manufacturing orders are placed for many common stock items made from raw materials once a year by the ordering group. A blanket order for each piece part is issued similar to the regular manufacturing orders except that no definite amount is specified when the order is placed, and material is drawn and schedules issued under control of the planning division.

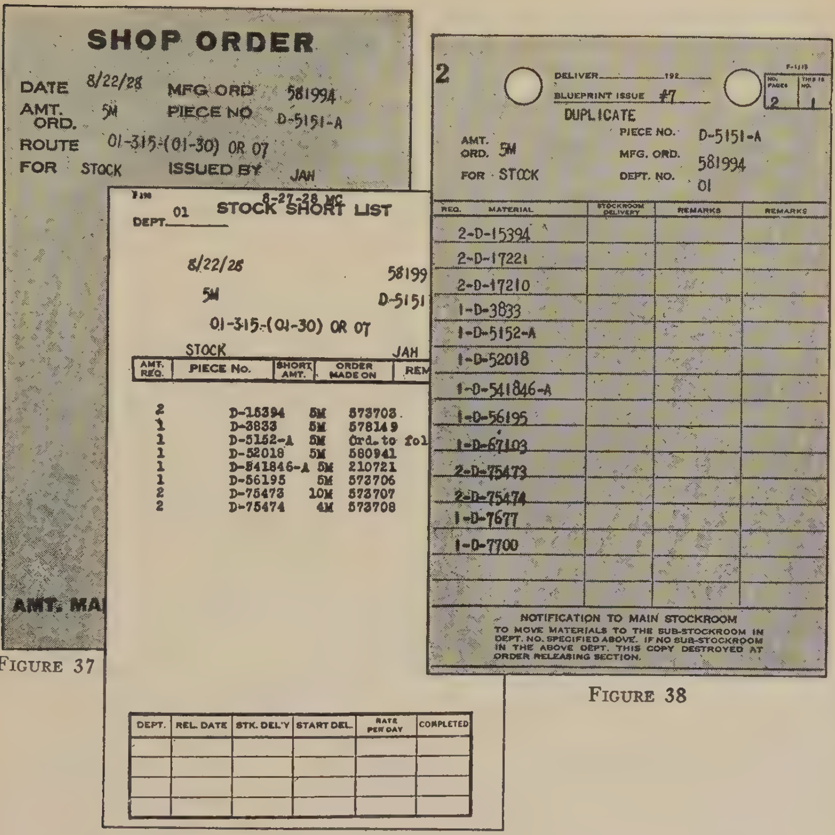
Stock orders on telephone and miscellaneous equipment are placed periodically by the ordering group in the regular manufacturing order series, to cover an approximate three months' supply. Quantities ordered are based on previous orders plus or minus anticipated requirements as furnished by the superintendent of production.

The placing of a blanket order instead of a separate entry every time a particular job is put through greatly simplifies the order entry routine in the first place, and it simplifies cost finding and other elements all along the line.

The orders come from the engineering department in either one of two ways; in the form of memoranda or of typed specifications. The typed specification method is the regular way, but where some special urgency exists an order may come through on a memorandum to be covered later by regular specifications.

Where production is ordered on memorandum the order is in duplicate. One copy goes to the ordering group and the other is routed to the office of the superintendent of production for information in compiling the master schedules, after which it is turned over to the planning division for information in advance of the official master schedules.

When equipment is ordered by specification, the engineering department furnishes a number of duplicate copies which are distributed in the production office as follows: (1) One copy is used for the ordering of equipment. This copy is held by the ordering group for two years; (2) a copy is used for the master schedules, and this is filed in the office of the superintendent of production; (3) a copy is used by the planning division, where it is filed until shipment is complete, after which it is destroyed. Notification of shipment is supplied by the production superintendent's office; (4) copies also go to the shop.



SHOP ORDER

DATE 8/22/28 MFG ORD 581994
AMT. ORD. 5M PIECE NO D-5151-A
ROUTE 01-315-(01-30) OR 07
FOR STOCK ISSUED BY JAH

AMT. MA

FIGURE 37

2

DELIVER ______ 192__
BLUEPRINT ISSUE #7
DUPLICATE

F-1113

NO. PAGES	THIS IS NO.
2	1

AMT. ORD. 5M
FOR STOCK
PIECE NO. D-5151-A
MFG. ORD. 581994
DEPT. NO. 01

REQ. MATERIAL	STOCKROOM DELIVERY	REMARKS	REMARKS
2-D-15394			
2-D-17221			
2-D-17210			
1-D-3833			
1-D-5152-A			
1-D-52018			
1-D-541846-A			
1-D-56195			
1-D-67103			
2-D-75473			
2-D-75474			
1-D-7677			
1-D-7700			

NOTIFICATION TO MAIN STOCKROOM
TO MOVE MATERIALS TO THE SUB-STOCKROOM IN DEPT. NO. SPECIFIED ABOVE. IF NO SUB-STOCKROOM IN THE ABOVE DEPT. THIS COPY DESTROYED AT ORDER RELEASING SECTION.

FIGURE 38

8-27-28 MC
DEPT. 01 STOCK SHORT LIST

8/22/28 58199
5M D-5151
01-315-(01-30) OR 07
STOCK JAH

AMT. REQ.	PIECE No.	SHORT AMT.	ORDER MADE ON	REM
2	D-15394	5M	573703	
1	D-3833	5M	578149	
1	D-5152-A	5M	Ord. to fol	
1	D-52018	5M	580941	
1	D-541846-A	5M	210721	
1	D-56195	5M	573706	
2	D-75473	10M	573707	
2	D-75474	4M	573708	

DEPT.	REL. DATE	STK. DEL'Y	START DEL.	RATE PER DAY	COMPLETED

FIGURE 39

All specifications and memoranda for ordering of product clear through the ordering group, where an analysis is made, sufficient information secured and wherever possible, orders for similar equipment are grouped for ordering. Memoranda and specifications with proper information for editing are then turned over to the order editor for assignment of manufacturing order numbers.

The order editor, on receipt of memorandum or specification to order, assigns a shop order form (Figure 37) for each item to be manufactured. Sometimes a number of different items which will eventually be used on the completed assembly are specified to be made on an order, as this saves transferring and inspection.

The order editor calls for the manufacturing blueprint for the item to be manufactured. The layout will contain all the information relative to the factory sequence of operations and any other special information regarding the part to be made. The shop routing is then typed on this form (Figure 37) together with all information supplied on the memorandum issued by the ordering group to complete the form of ordering. The routing is indicated, as will be seen from Figure 37, by a series of department numbers, each number separated by a dash. The numbers are in the sequence in which the job is routed.

A copy of this form (Figure 37) together with the blueprint and layout is then delivered to the stocklist writing group, where the stocklist form (Figure 38) will be written on a billing machine, showing the amount to be made and detailing the various pieces and drawing numbers, wire, screws, and other material as shown on the blueprint that enter into the assembly specified.

When the proper entries have been made on the shop order form (Figure 37), all in duplicating ink, as many as 10 other forms used on the order may be run off on the duplicating machine. These include stocklist (for assemblies), stocklist (for raw materials), office count card, shop order, shop count card, schedule card, stock short list, functional check sheet, form issued on sales orders for pick-up of drafting labor chargeable by the cost department, and the master tabulating time card.

The shop superintendent's copy is routed to the stock records section for entry on the stock record card so that reference can be made at this point as to manufacturing orders placed on this particular part. It is then filed in numerical sequence according to order number for any future reference by the production or cost departments.

The regular stock list (Figure 38), which is already explained is made up from the blueprint and lists the individual parts that go into the assembly, is made up on the billing machine in six copies. After being checked for legibility, they are delivered to the crouching desks.

All the items on the stocklist are vouched for on one of these copies by each voucher clerk in turn, each voucher clerk being responsible for his particular section. The vouchers make a notation against each item on the stock list to the effect that the balance on hand is sufficient to take care of the requirement, by OK'ing, and if not in stock or on order in sufficient quantity, places an order with the order editor and ascertains the manufacturing number to be assigned, so that this information can be placed against the item or items short. When the stocklist has finally cleared through all the vouching desks, it is turned over to the stock short list typist, who will pair it with the stock short list form (Figure 39), which has previously arrived at her desk.

This stock short list form is the medium through which the production planner can tell at a glance either of two conditions existing on the order at hand: (1) stock on the order is O. K. and schedules can be sent out specifying the completion date desired, or (2) certain items of material are not in stock and will have to be manufactured. The schedule date in this case cannot be determined until schedules on the parts short can be ascertained.

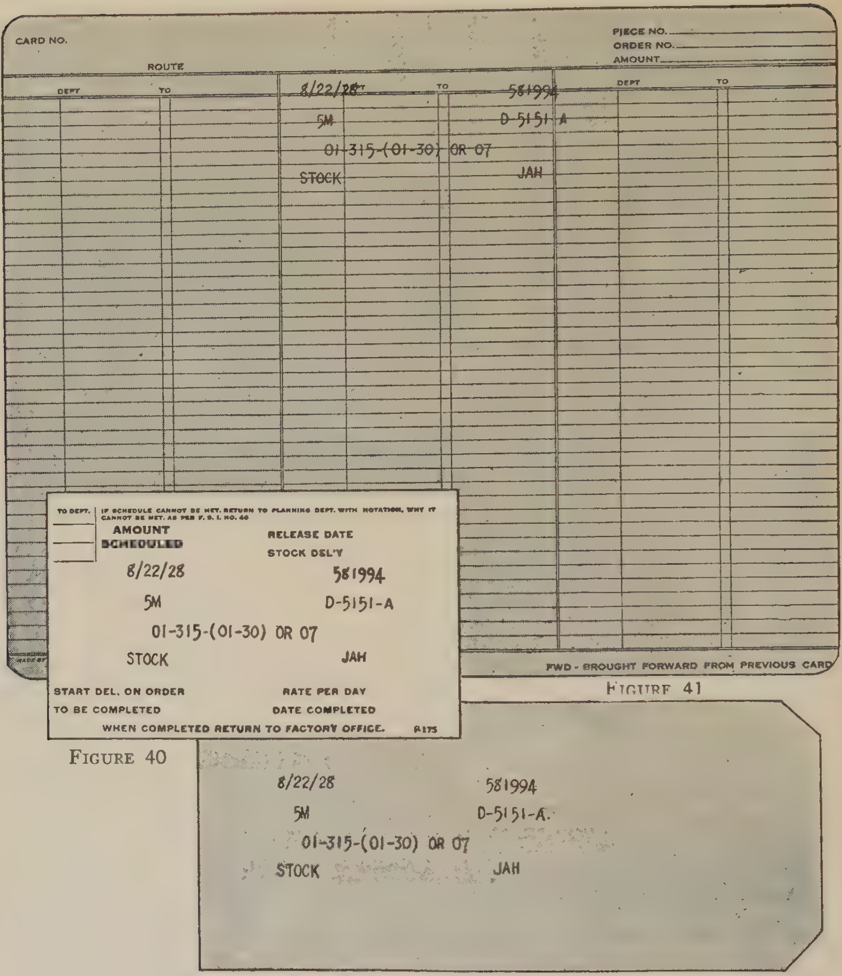
As soon as the planning section sends through a schedule to the order releasing department, the shop orders and the stock list are released. One copy is forwarded to the general stockroom and upon its receipt this stockroom transfers all items of stock not regularly kept in the sub-stockroom where the order is to be assembled. The other copies go to the shop department where the order is to be assembled and are filed in numerical sequence by the shop clerk.

A schedule card (Figure 40) is delivered to the dispatcher, who is the production department's representative in the shop. The reason for the schedule card is this: the stock list goes through the office at once but is not released in the shop immediately. In fact, it may stay in this condition for a month. So when the planner receives this schedule card he lets the stock list go or not according to the information he has on hand. If the dispatcher cannot meet the date he sends the schedule card back to the planner with a notation as to why it cannot be met.

It should be explained that in our plant the foreman has nothing to say as to what will run and when. That is up to the planning and dispatching departments.

An interesting control form is the work in progress count card (Figure 41). It is kept in the production office on a bookkeeping machine, so that everybody in the production department can tell the status of an order at all times. As is evident from a glance at this form, the blank spaces are arranged to accommodate the number of the departments from which and to which parts are sent, the date, the amount transferred on that date and the total amount to date.

Another simple card, but one which performs a valuable function,



CARD NO.
ROUTE
PIECE NO.
ORDER NO.
AMOUNT

DEPT	TO	DEPT	TO	DEPT	TO
		8/22/28	581994		
		5M	D-5151-A		
		01-315-(01-30) OR 07			
		STOCK	JAH		

FWD - BROUGHT FORWARD FROM PREVIOUS CARD

FIGURE 41

TO DEPT.

IF SCHEDULE CANNOT BE MET, RETURN TO PLANNING DEPT. WITH NOTATION, WHY IT CANNOT BE MET. AS PER F. S. I. NO. 40

AMOUNT SCHEDULED

RELEASE DATE

STOCK DEL'Y

8/22/28 581994

5M D-5151-A

01-315-(01-30) OR 07

STOCK JAH

START DEL. ON ORDER

RATE PER DAY

TO BE COMPLETED

DATE COMPLETED

WHEN COMPLETED RETURN TO FACTORY OFFICE. R175

FIGURE 40

8/22/28 581994

5M D-5151-A

01-315-(01-30) OR 07

STOCK JAH

FIGURE 42

is the master tabulating card (Figure 42). This is a plain card of the same size and shape as the tabulating time card, and all that it has on it is the impression made by the duplicating machine at the time that the shop orders were issued, as has already been mentioned. It is on salmon colored stock and so stands out in contrast with the manila tabulating time cards. It serves as a separator in the time card file behind which all the time cards for that particular job are accumulated. And the information which is duplicated on it shows the file clerk whether he has the right order and part number when he is accumulating the time cards against the order. It also serves as a check on the amount made, the date, amount transferred, and so forth.

Another form of value all out of proportion to its small size (5x8) is the checking sheet which has been mentioned as one of the forms struck off on the duplicating machine at the same time that the stocklist, office count card, shop order and so on are made out.

This sheet is a form listing down the left edge of the upper half of the sheet the printed notations, "Departments orders all in, count card checked, stocklist complete, material all drawn, repair orders complete, parts repaired transferred, transfers for parts scrapped," and at the right of each of these notations are blank spaces.

When an order is completed we send someone out into the shop to pick up all the forms of every sort that were involved on that order. Then we use this check sheet to assure ourselves that everything is complete and that all transfers have been properly made.

A system for system's sake is of course the rankest of follies. The true test of a routine method is what it costs in proportion to what it accomplishes. I don't mean to imply that we have by any means reached the ultimate in this scheme of ours, but we count it successful because it has reduced the force in the production office from 100 to 64. And this has been in considerable part due to an analysis of each job involved.

And the bonus in its application to many of the office jobs has played a large part too. We try to impress upon employees the importance of doing the job right. Here is an example of how the bonus helps in impressing accuracy. When we cannot find a part in the stockrooms which our records show is in existence, we frequently ask that all the boxes be "pulled" until the missing parts show up. Occasionally this results in a cost of as much as $50 to find a $5 item. The expense comes out of the bonus and the effect on the stockroom people at fault cannot but be good.

It should not be interpreted from this that we insist upon reconciling all items at all times irrespective of the value of the item involved. A system with too great a degree of refinement may be almost as bad as none at all, but the extent to which you are to carry the refinement should be taken into account in the planning of the sytsem in the first place. It should not be left to the individual interpretation of the men who work the plan.

A PLANNING DEPARTMENT THAT PRODUCES RESULTS

By JOSEPH M. SCHAPPERT

Assistant Works Manager, American Schaeffer and Budenberg Corporation, Brooklyn

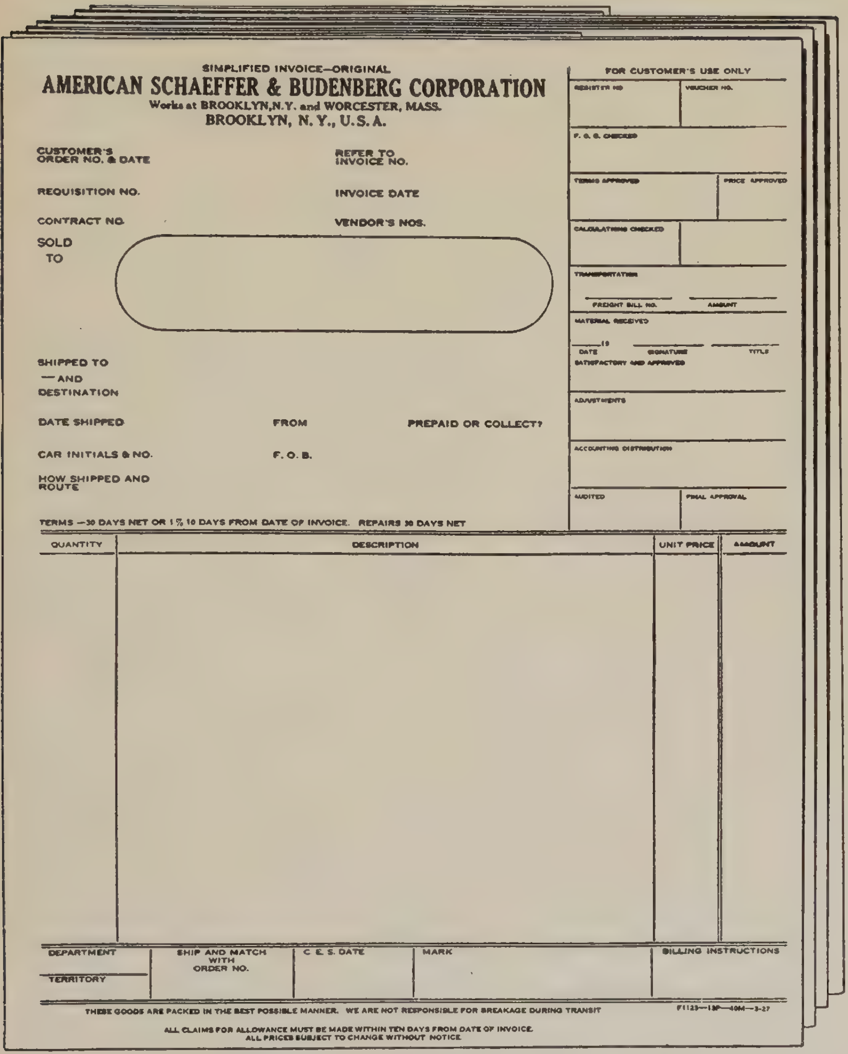
PLANNING work is one angle of business which each day grows increasingly more important. The narrowing margin between cost and sales price insists that management know definitely what it is doing, what products it will make, and where, and how it will make them; deliveries must be speedy because management has been taught to keep cash liquid and avoid excessive inventories.

The major functions of a planning department are, generally, to decide, record, and instruct on: (a) what work is to be done; (b) where work is to be done; (c) when work is to be done; (d) how work is to be done. Its usual sections consist of: Routing: prescribing the path which work will follow; Scheduling: planning the amount of work to be done; Dispatching: seeing that orders are issued, materials and tools on hand, job cards issued, and that schedules are carried out properly.

Tracing the procedure in our own planning department, to start with we must know what to make. This is arrived at primarily by merchandising demands, research, development and final release of finished article by engineering department to planning department. In the various stages of development it is the duty of the planning department to supply the engineering department, upon request, with all the information available and procurable as to tooling, machining, and so on, toward the end that this knowledge be incorporated in the final design.

Regularly, with current items, what to be made is authorized by: (1) catalog; (2) shop orders (from sales department to planning department); (3) suborders (from planning department to shop departments); (4) stock orders (from planning department for goods to be kept in stock); (5) repair orders (from sales department to planning department); and (6) internal shop orders for experimental, drafting, tool and maintenance work. These are all passed on by the planning department.

In determining where work is to be done: (1) Outside purchases are requisitioned by inventory division, planning department; (2)



SIMPLIFIED INVOICE—ORIGINAL

AMERICAN SCHAEFFER & BUDENBERG CORPORATION

Works at BROOKLYN, N.Y. and WORCESTER, MASS.
BROOKLYN, N. Y., U.S.A.

CUSTOMER'S ORDER NO. & DATE
REFER TO INVOICE NO.
REQUISITION NO.
INVOICE DATE
CONTRACT NO.
VENDOR'S NOS.
SOLD TO
SHIPPED TO — AND DESTINATION
DATE SHIPPED
FROM
PREPAID OR COLLECT?
CAR INITIALS & NO.
F. O. B.
HOW SHIPPED AND ROUTE

TERMS —30 DAYS NET OR 1% 10 DAYS FROM DATE OF INVOICE. REPAIRS 30 DAYS NET

FOR CUSTOMER'S USE ONLY

REGISTER NO
VOUCHER NO.
F. O. B. CHECKED
TERMS APPROVED
PRICE APPROVED
CALCULATIONS CHECKED
TRANSPORTATION
FREIGHT BILL NO.
AMOUNT
MATERIAL RECEIVED
______19
DATE
SIGNATURE
TITLE
SATISFACTORY AND APPROVED
ADJUSTMENTS
ACCOUNTING DISTRIBUTION
AUDITED
FINAL APPROVAL

QUANTITY	DESCRIPTION	UNIT PRICE	AMOUNT

DEPARTMENT
TERRITORY
SHIP AND MATCH WITH ORDER NO.
C. E. S. DATE
MARK
BILLING INSTRUCTIONS

THESE GOODS ARE PACKED IN THE BEST POSSIBLE MANNER. WE ARE NOT RESPONSIBLE FOR BREAKAGE DURING TRANSIT

F1123—13P—40M—3-27

ALL CLAIMS FOR ALLOWANCE MUST BE MADE WITHIN TEN DAYS FROM DATE OF INVOICE.
ALL PRICES SUBJECT TO CHANGE WITHOUT NOTICE.

FIGURE 43. *This order form, comprising thirteen copies, is made out by the order department; the original order is sent to the filing department. Copies are routed, as explained in the text, to the proper points; each bearing its designation "shop order," "production chaser," and so forth*

instructions clerk, planning department, reviews all orders and checks operations and departments in which work is to be done.

To determine when work is to be done: All promise dates are set by order clerk, planning department, working in close harmony with order of work division. Each order is followed daily, by operations, by follow-up clerk. Visible control (visible index method) of each order is kept in the planning department, under jurisdiction of the order of work division.

How work is to be done is determined as follows: Design is received from engineering department. Planning department insists that all drawings be properly dimensioned and that proper tolerances are shown. Instructions clerk records matters of operations layout, tools, parts lists, materials, and instructions. Orders received are censored by instructions clerk and, as needed, special specifications added to order; sketches are also supplied as required. The final arbiter of how work should be done is under engineering department authority. This includes inspection of all raw materials and purchased parts to insure checking with purchase order specifications, and final inspection of finished goods to insure conformity to specifications.

This sums up the planning department's activities in deciding, recording, and instructing on what work is to be done and where, when, and how to do it.

To the left of the printed form reproduced at the head of this article is a description of the part with related information, and to the right a check sheet showing present balance of stock, stock movements, what we have done to overcome short balances, and necessary approvals for so doing. With this method we check each part on our inventory at least four times a year and in a large measure "bumpy" stock situations are obviated. In addition to this check we hold individual stock-bin signal cards or "flags" from which the stock clerks notify us of stock shortages.

We show below, at the left, the flow of order for goods to be made on order, and, at the right, the flow of order for goods to be delivered from stock. We will follow only the planning department contacts here:

The original order comes from the customer, through the salesman, to our mailing, credit, statistical, and order departments. It is converted to our 13-form order set; the original order being sent to the filing department.

Out of the order department, going to the planning department,

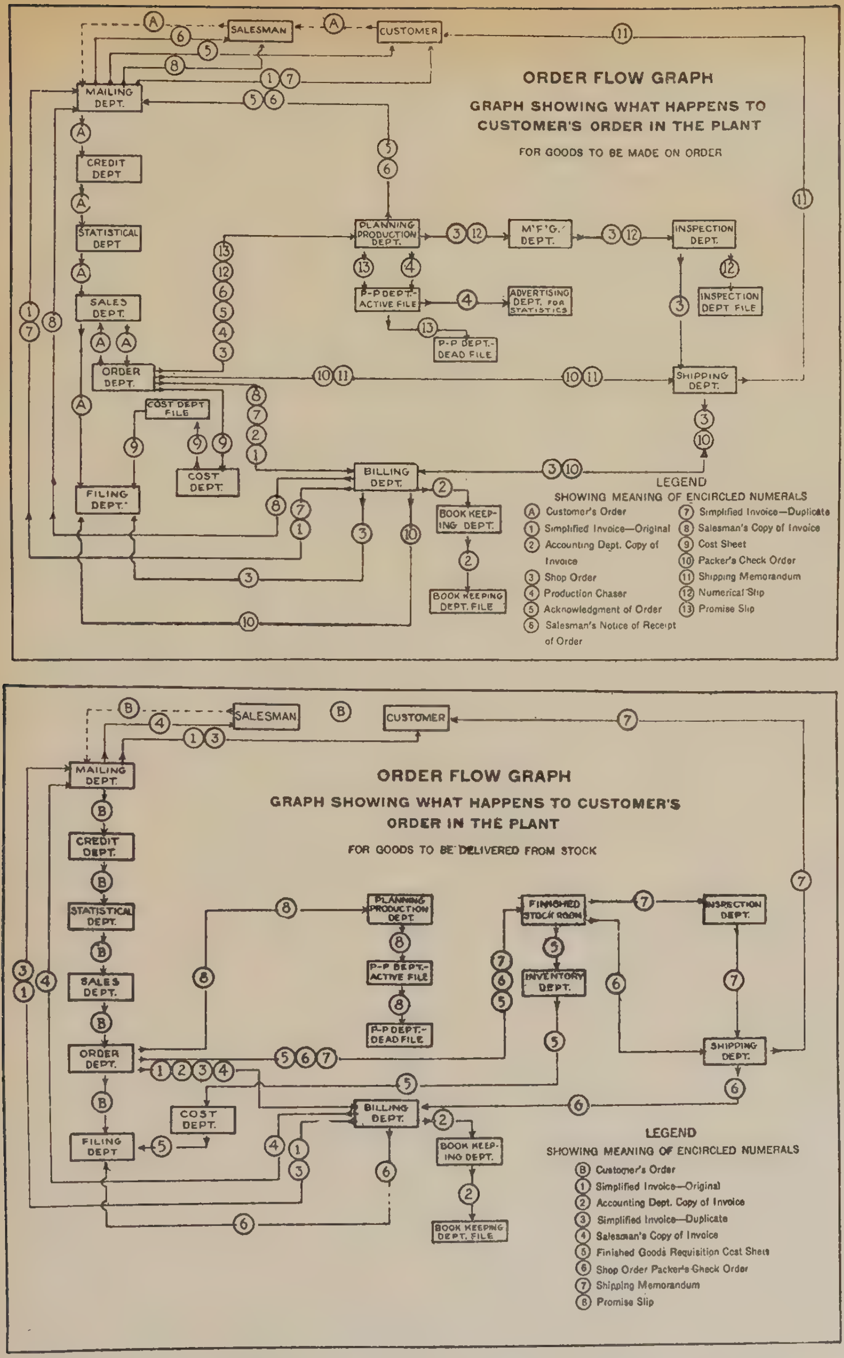

ORDER FLOW GRAPH
GRAPH SHOWING WHAT HAPPENS TO CUSTOMER'S ORDER IN THE PLANT
FOR GOODS TO BE MADE ON ORDER
SALESMAN
CUSTOMER
MAILING DEPT.
CREDIT DEPT
STATISTICAL DEPT
SALES DEPT.
ORDER DEPT.
COST DEPT FILE
COST DEPT.
FILING DEPT.
PLANNING PRODUCTION DEPT.
P-P DEPT.-ACTIVE FILE
P-P DEPT.-DEAD FILE
ADVERTISING DEPT. FOR STATISTICS
M'F'G. DEPT.
INSPECTION DEPT.
INSPECTION DEPT FILE
SHIPPING DEPT.
BILLING DEPT.
BOOK KEEPING DEPT.
BOOK KEEPING DEPT. FILE
LEGEND
SHOWING MEANING OF ENCIRCLED NUMERALS
Ⓐ Customer's Order
① Simplified Invoice—Original
② Accounting Dept. Copy of Invoice
③ Shop Order
④ Production Chaser
⑤ Acknowledgment of Order
⑥ Salesman's Notice of Receipt of Order
⑦ Simplified Invoice—Duplicate
⑧ Salesman's Copy of Invoice
⑨ Cost Sheet
⑩ Packer's Check Order
⑪ Shipping Memorandum
⑫ Numerical Slip
⑬ Promise Slip
ORDER FLOW GRAPH
GRAPH SHOWING WHAT HAPPENS TO CUSTOMER'S ORDER IN THE PLANT
FOR GOODS TO BE DELIVERED FROM STOCK
SALESMAN
CUSTOMER
MAILING DEPT.
CREDIT DEPT.
STATISTICAL DEPT.
SALES DEPT.
ORDER DEPT.
COST DEPT.
FILING DEPT
PLANNING PRODUCTION DEPT
P-P DEPT.-ACTIVE FILE
P-P DEPT.-DEAD FILE
FINISHED STOCK ROOM
INVENTORY DEPT.
INSPECTION DEPT.
SHIPPING DEPT.
BILLING DEPT.
BOOK KEEPING DEPT.
BOOK KEEPING DEPT. FILE
LEGEND
SHOWING MEANING OF ENCIRCLED NUMERALS
Ⓑ Customer's Order
① Simplified Invoice—Original
② Accounting Dept. Copy of Invoice
③ Simplified Invoice—Duplicate
④ Salesman's Copy of Invoice
⑤ Finished Goods Requisition Cost Sheet
⑥ Shop Order Packer's Check Order
⑦ Shipping Memorandum
⑧ Promise Slip

FIGURE 44. *The diagram at the top shows the flow of order for goods to be made on order; the one at the bottom shows the flow of order for goods to be delivered from stock*

we follow copies 3, 4, 5, 6, 12 and 13, shop order, production chaser, acknowledgment of order, salesman's notice of receipt of order, numerical slip and promise slip respectively. In the planning department the order is analyzed by the instructions clerk and where necessary, blue-prints and other data procured from the drafting department, or a special sketch made. The order then proceeds to the order clerk, who analyzes the order and sets the promise date. The promise date is placed upon all copies and the acknowledgment of order and salesman's notice of receipt of order are forwarded to the mailing department from which they are forwarded to the customer and salesman respectively. The shop order and numerical order together with all requisitions and suborders go to the manufacturing department through the stock-room. When goods are made, both copies are delivered to the inspection department where the numerical copy is kept, filed according to serial number, and the shop order, after inspection of the goods, sent with the goods to the shipping department. The promise slip and production chaser are kept in the planning department files until the order is delivered for shipment and then the promise slip is transferred to a production department dead file and the production chaser is sent to the advertising department for statistics.

In the manner just related, the customer's order reaches the order department and is converted into an eight-form order set. Of this set the planning department receives but one—Number 8, the promise slip—as a record of the order, and this is held, alphabetically by customer's name, until goods are shipped.

PRODUCTION CONTROL FOR LOWER COSTS

By F. B. CALHOUN

Manager, Production Control Division, Goodyear Tire and Rubber Company

THE organization of the factory departments and of the production control division in the plant of the Goodyear Tire and Rubber Company, at Akron, is shown diagramatically in Figures 45, 46 and 47. The production control division is headed by an assistant superintendent in charge of production service and is actively supervised by the manager of the production control division. He has three men in direct charge of the three main divisions of the work—manager of production control in plant No. 1, man-

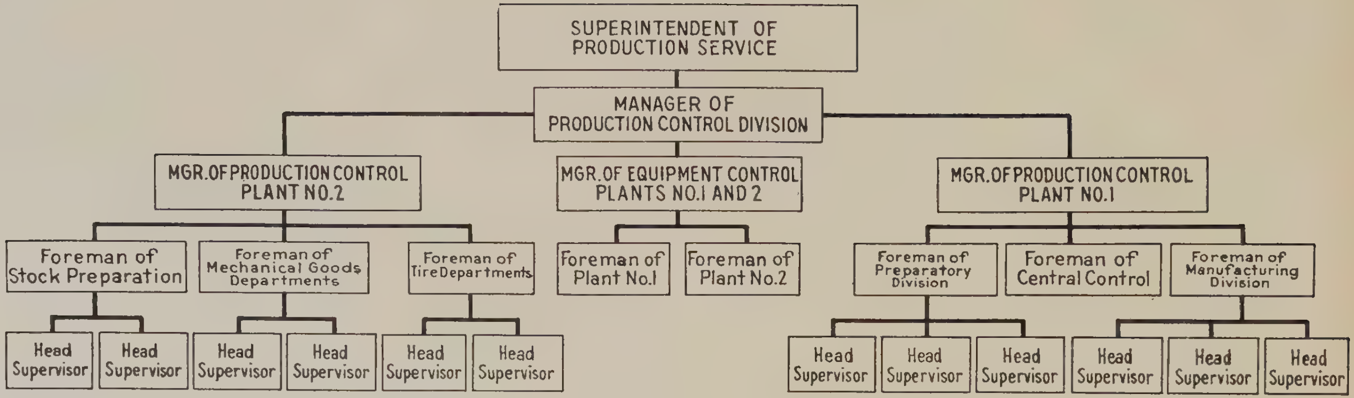

SUPERINTENDENT OF PRODUCTION SERVICE
MANAGER OF PRODUCTION CONTROL DIVISION
MGR. OF PRODUCTION CONTROL PLANT NO. 2
MGR. OF EQUIPMENT CONTROL PLANTS NO. 1 AND 2
MGR. OF PRODUCTION CONTROL PLANT NO. 1
Foreman of Stock Preparation
Foreman of Mechanical Goods Departments
Foreman of Tire Departments
Foreman of Plant No. 1
Foreman of Plant No. 2
Foreman of Preparatory Division
Foreman of Central Control
Foreman of Manufacturing Division
Head Supervisor
Head Supervisor
Head Supervisor
Head Supervisor
Head Supervisor
Head Supervisor
Head Supervisor
Head Supervisor
Head Supervisor
Head Supervisor
Head Supervisor
Head Supervisor

FIGURE 45. *Organization chart of production service division*

ager of production control in plant No. 2, and manager of equipment control in plants 1 and 2. The production control managers regulate the flow of work through their respective plants. Each has three assistants, or foremen, in charge of divisions of the work shown in Figure 45. These men, in turn, except for the central control department in plant No. 1, have head supervisors to carry the detailed responsibility classified under further breakdown of duties.

The equipment manager attends to all maintenance and repairs of auxiliary equipment, such as cores, molds, inserts, etc., and sees that it is at all times in perfect operating condition.

Figures 46 and 47, respectively, show the subdivisions of production control responsibilities in detail for plants 1 and 2. In the actual chart the names of the men holding these positions are listed under each heading, but these names have been omitted in the reproduction. The numbers tell how many men are in each group. This data is summarized in Table 9, while in Table 10 are outlined the main duties which each man performs.

PRODUCTION CONTROL DISTINCT FROM MANUFACTURING

The production control organization of the plant is entirely separate and distinct from the actual production personnel. The foremen and workmen engaged in manufacturing devote all their time and attention to making products. They are responsible for the quality, quantity and rate of output of work on schedules made out by the control division and based on exhaustive studies to determine reasonable capacities of men and equipment. The production departments have nothing to do with the coming in or going out of materials, the upkeep of equipment, the hiring or transfer of employees, the scheduling and dispatching of work, nor any other non-production operation. Each workman is assigned a definite task, all materials and equipment are furnished him, and completed work is removed when he has finished it. The foremen are responsible for amount and quality of output, have complete charge of their departments, and are held to account for results.

Most of the work requires special training and an ability which classes workmen in the grade of skilled mechanics. The production increase per worker brought about has resulted from the facilities provided the men, the skill that they have been able to acquire, the establishing of piece rates which give them steady earnings higher than in most trades and mechanical pursuits, the freedom from personal annoyances, delays and friction which are likely to arise in plants where autocratic foremen are given unlimited authority, and the continual effort made to reduce physical exertion and fatigue and make work easier to perform—a policy mutually beneficial.

The production program in the Goodyear plant is planned to a large extent from data collected by the sales department through its distributing branches in various important marketing centers. A thorough survey of market conditions is made by the merchandise distribution department based on this information furnished by the sales department. Automobile production is closely watched so that the tire and tube requirements of car manufacturers and users can be forecast. For such products as belting, hose, heels, etc., contact is maintained with manufacturers, dealers, export trade, and other outlets, to keep production in pace with demand.

YEARLY ESTIMATE BASIS

A yearly estimate is developed outlining probable annual requirements on each product manufactured by the company. This program is thoroughly analyzed by the management and, if approved, additional capacities of equipment and plant, where necessary, are provided accordingly. Generally speaking, the merchandise distribution department is required to keep within the limits decided upon, which show the various sizes, types, etc., of products to be made. These estimates are subject to revision as often as conditions warrant.

The production control division breaks down these estimates into their component parts and develops a tentative purchasing schedule, showing the quantity of material required, thereby permitting the purchasing department to make market surveys for future contracts. Reports from the sales branches all over the country showing the quantity on hand at each branch, the amount en route and probable sales for the following month, are used by the merchandise distribution to check its estimates and also to develop shipping schedules for the branches.

The specific periods for which detailed tentative production

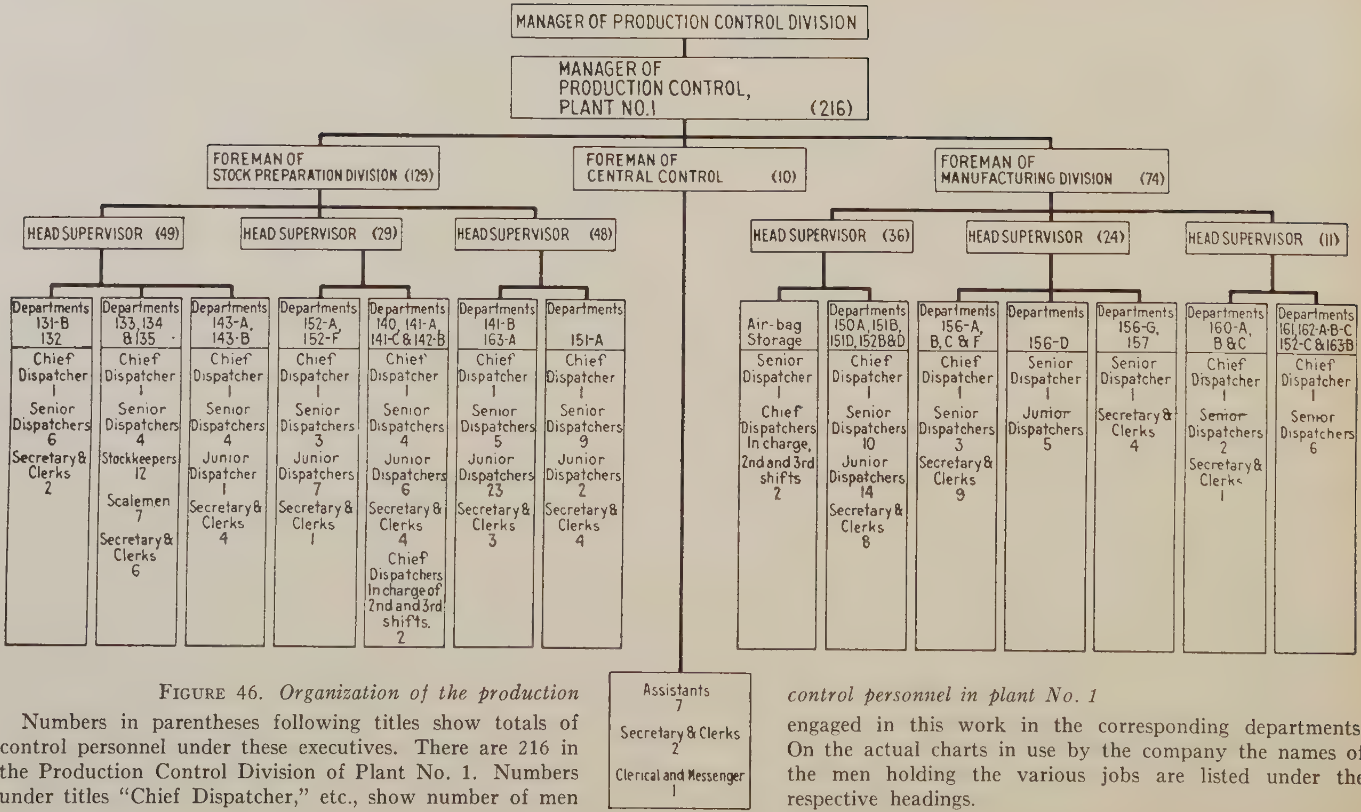

MANAGER OF PRODUCTION CONTROL DIVISION
MANAGER OF PRODUCTION CONTROL, PLANT NO.1 (216)
FOREMAN OF STOCK PREPARATION DIVISION (129)
FOREMAN OF CENTRAL CONTROL (10)
FOREMAN OF MANUFACTURING DIVISION (74)
HEAD SUPERVISOR (49)
HEAD SUPERVISOR (29)
HEAD SUPERVISOR (48)
HEAD SUPERVISOR (36)
HEAD SUPERVISOR (24)
HEAD SUPERVISOR (11)
Departments 131-B 132
Chief Dispatcher 1
Senior Dispatchers 6
Secretary & Clerks 2
Departments 133, 134 & 135
Chief Dispatcher 1
Senior Dispatchers 4
Stockkeepers 12
Scalemen 7
Secretary & Clerks 6
Departments 143-A, 143-B
Chief Dispatcher 1
Senior Dispatchers 4
Junior Dispatcher 1
Secretary & Clerks 4
Departments 152-A, 152-F
Chief Dispatcher 1
Senior Dispatchers 3
Junior Dispatchers 7
Secretary & Clerks 1
Departments 140, 141-A, 141-C & 142-B
Chief Dispatcher 1
Senior Dispatchers 4
Junior Dispatchers 6
Secretary & Clerks 4
Chief Dispatchers In charge of 2nd and 3rd shifts. 2
Departments 141-B 163-A
Chief Dispatcher 1
Senior Dispatchers 5
Junior Dispatchers 23
Secretary & Clerks 3
Departments 151-A
Chief Dispatcher 1
Senior Dispatchers 9
Junior Dispatchers 2
Secretary & Clerks 4
Assistants 7
Secretary & Clerks 2
Clerical and Messenger 1
Air-bag Storage
Senior Dispatcher 1
Chief Dispatchers In charge, 2nd and 3rd shifts 2
Departments 150A, 151B, 151D, 152B&D
Chief Dispatcher 1
Senior Dispatchers 10
Junior Dispatchers 14
Secretary & Clerks 8
Departments 156-A, B, C & F
Chief Dispatcher 1
Senior Dispatchers 3
Secretary & Clerks 9
Departments 156-D
Senior Dispatcher 1
Junior Dispatchers 5
Departments 156-G, 157
Senior Dispatcher 1
Secretary & Clerks 4
Departments 160-A, B & C
Chief Dispatcher 1
Senior Dispatchers 2
Secretary & Clerks 1
Departments 161, 162-A-B-C 152-C & 163B
Chief Dispatcher 1
Senior Dispatchers 6

FIGURE 46. *Organization of the production control personnel in plant No. 1*

Numbers in parentheses following titles show totals of control personnel under these executives. There are 216 in the Production Control Division of Plant No. 1. Numbers under titles "Chief Dispatcher," etc., show number of men engaged in this work in the corresponding departments. On the actual charts in use by the company the names of the men holding the various jobs are listed under the respective headings.

schedules are built up vary with the products under consideration. Some items can be scheduled ahead to March of the following year. Manufacture of pneumatic and solid tires, rubber heels, etc., can be planned in the late winter for the balance of the current year. Consumption of these products is greatest in the spring, summer and early fall, and it is comparatively easy in some cases to tell closely several months ahead what the sales prospects are for the approaching active season. Several products, toward the latter part of the year, can be scheduled for manufacture quite definitely 9 to 12 months in advance.

Although the merchandise distribution department knows the approximate capacity of the plant for all products, there are periods when it must confer specially with the production control division. Occasionally sales increases on certain products may largely exceed previous plans and require greater floor space, more equipment, more men and more materials. Likewise a decrease in sales may mean that curtailment must be made in output. Consequently, a definite tentative manufacturing schedule, broken down into specific quantities of each item, compiled from the market reports, is delivered to the production control division 60 days in advance of going into effect. The factory has an opportunity to state whether or not the tentative program is possible.

ORDERING MATERIALS

This schedule forms the basis for releases and planning the requisitions of those materials which have not been previously ordered on a contract basis, and on which quick shipments can be secured. Records of previous years are gone over to trace the course of seasonal trends. The inventory carried depends on the ease of securing materials. The production control division regulates the inventory on all productive materials.

From the above tentative production schedule, a purchasing budget of materials required and their probable cost is prepared. This is sent to the assistant comptroller. When approved by him it goes to the purchasing department as an authorization to fill the requisitions which will be placed by the production control division. Any questions concerning the budget are decided between the assistant comptroller and the production control division.

The purchase budget thus made up shows the quantities of materials on hand, en route and on order, and the coming month's requirements. In addition, the definite needs for two months ahead and the probable needs for six months ahead are listed. The probable inventory is also calculated for six months in advance. These latter figures form the basis for contracts for materials which can be most advantageously purchased on commitments and released on shipping orders.

The actual purchase requisitions are made out after these budgets have been approved. The backs of the requisition forms are ruled for purchase records. A card record is maintained of the purchases of similar materials during previous years for checking purposes. Arrivals of materials and a statement of their inspection for quality and quantity are reported by the receiving department to the purchasing department, production control, storerooms and accounts payable departments.

Rubber purchases involve extensive raw materials market studies

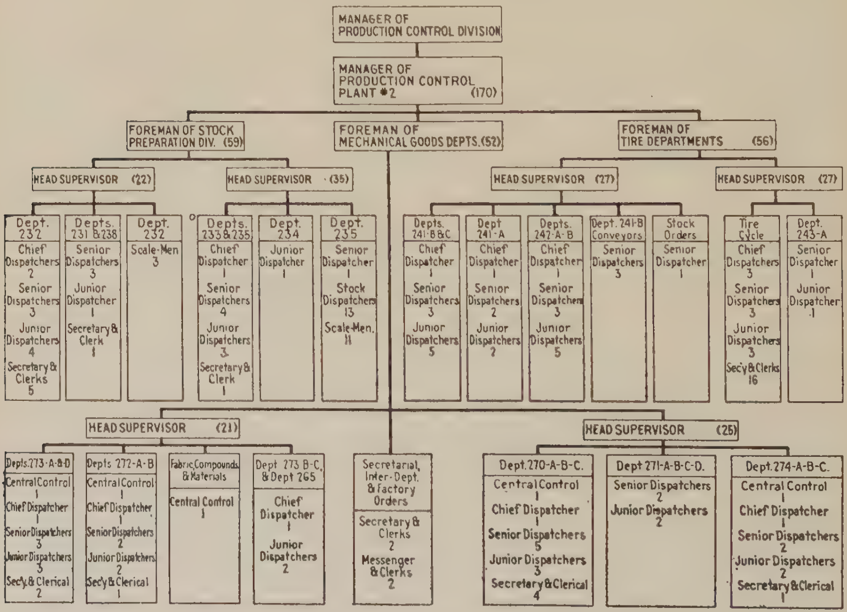

MANAGER OF PRODUCTION CONTROL DIVISION
MANAGER OF PRODUCTION CONTROL PLANT #2 (170)
FOREMAN OF STOCK PREPARATION DIV. (59)
FOREMAN OF MECHANICAL GOODS DEPTS. (52)
FOREMAN OF TIRE DEPARTMENTS (56)
HEAD SUPERVISOR (22)
HEAD SUPERVISOR (35)
HEAD SUPERVISOR (27)
HEAD SUPERVISOR (27)
Dept. 232 Chief Dispatchers 2 Senior Dispatchers 3 Junior Dispatchers 4 Secretary & Clerks 5
Depts. 231 & 238 Senior Dispatchers 3 Junior Dispatcher 1 Secretary & Clerk 1
Dept. 232 Scale-Men 3
Depts. 233 & 235 Chief Dispatcher 1 Senior Dispatchers 4 Junior Dispatchers 3 Secretary & Clerk 1
Dept. 234 Junior Dispatcher 1
Dept. 235 Senior Dispatcher 1 Stock Dispatchers 13 Scale-Men. 11
Depts. 241-B & C Chief Dispatcher 1 Senior Dispatchers 3 Junior Dispatchers 5
Dept 241-A Chief Dispatcher 1 Senior Dispatchers 2 Junior Dispatchers 2
Depts. 242-A-B Chief Dispatcher 1 Senior Dispatchers 3 Junior Dispatchers 5
Dept. 241-B Conveyors Senior Dispatchers 3
Stock Orders Senior Dispatcher 1
Tire Cycle Chief Dispatchers 3 Senior Dispatchers 3 Junior Dispatchers 3 Sec'y & Clerks 16
Dept. 243-A Senior Dispatcher 1 Junior Dispatcher 1
HEAD SUPERVISOR (21)
HEAD SUPERVISOR (25)
Depts. 273-A-&-D Central Control 1 Chief Dispatcher 1 Senior Dispatchers 3 Junior Dispatchers 3 Sec'y. & Clerical 2
Depts 272-A-B Central Control 1 Chief Dispatcher 1 Senior Dispatchers 2 Junior Dispatchers 2 Sec'y & Clerical 1
Fabric, Compounds & Materials Central Control 1
Dept 273 B-C, & Dept 265 Chief Dispatcher 1 Junior Dispatchers 2
Secretarial, Inter-Dept. & Factory Orders Secretary & Clerks 2 Messenger & Clerks 2
Dept. 270-A-B-C. Central Control 1 Chief Dispatcher 1 Senior Dispatchers 5 Junior Dispatchers 3 Secretary & Clerical 4
Dept 271-A-B-C-D. Senior Dispatchers 2 Junior Dispatchers 2
Dept. 274-A-B-C. Central Control 1 Chief Dispatcher 1 Senior Dispatchers 2 Junior Dispatchers 2 Secretary & Clerical 1

FIGURE 47. *Organization of production control in plant No. 2*

Numbers in parentheses following titles show totals of control personnel under these executives. Numbers under titles "Chief Dispatchers," etc., show number of men engaged in this work in the corresponding department.

and require such careful supervision that they are handled directly under the jurisdiction of the management.

Fifty per cent of the cotton fabric for tires is produced in five mills owned by the company and located in various parts of the country. The rest is purchased. Each day a fabric situation report is prepared at the Akron plant, showing quantities on hand, received the day before and disbursed the day before. A daily check of use against estimates is carried.

PLANNING THE DETAILS OF PRODUCTION

As before stated, the merchandise distribution forwards to the production control division tentative production programs for periods varying from 60 days to one year. This estimate is broken down into machine capacities, and the production control department, working in conjunction with the planning department, makes recommendations regarding any additional layout changes required.

TABLE 9

SUMMARY OF CLASSIFICATION OF PRODUCTION CONTROL PERSONNEL

	NUMBER EMPLOYED			
Classification	*Plant No. 1*		*Plant No. 2*	
1. Foremen		3		3
2. Head supervisors		6		6
3. Central control		7		5
4. Chief dispatchers	15		14	
5. Senior dispatchers	59		41	
6. Junior dispatchers	58		39	
7. Stock dispatchers	12		13	
8. Scalemen	7		14	
9. Secretarial and clerical and checkers	48		33	
10. Clerical and messenger	1		2	
11. Present dept. average		200		156
Total in Plant		216		170
Total in Plant No 1				216
Total in Plant No. 2				170
Assistant superintendent and manager				2
Total				388

A department of the production control division orders and supervises repairs on all auxiliary equipment such as cores, molds, dies, etc. This procedure is very important in the control of the raw material situation because a definitely prearranged schedule, preceded by predetermined material requisitions and releases, must be obtained if a rapid material turnover is desired. No material can therefore be ordered until a thorough analysis has been made to determine that all equipment is available to meet the prearranged requirements planned. In case the various departments affected are not properly synchronized, surplus inventories result.

Daily, weekly, bi-weekly or monthly manufacturing schedules, depending upon the product, are made up within the limits of previous estimates in so far as possible, and forwarded in advance through managerial channels to the production control division.

CLASSIFICATION OF PRODUCTS

Generally speaking, all products are classified as follows: First, standard stock. Under this classification are all products sold in sufficient quantity to justify stocking both at Akron and in the branches. Second, Akron stock. Under this classification are all products sold in sufficient quantity to justify a stock at Akron only. Third, special manufacture. Under this classification are products made to order only, such as customers' brands, conveyor belting, hand-built hose, etc.

When these requirements are received by the central control division, they are broken down into daily machine schedules, from which assignment orders are issued. In the compilation of these schedules the following points are considered: First, economical grouping in order to obtain maximum machine capacities. Second, relative importance of orders on hand. Emergency, promised, express orders, etc., are all considered at the time the daily schedule is written.

Even with this basis of scheduling in effect, it has been necessary to develop an emergency order system due to the policy of low inventories in all lines of industry. It is possible, with the flexibility which has been created, to route orders through the different production operations and have them available for shipment within time limits varying from 8 hours to 18 days, depending upon the importance of the order and kind of product. Incidentally, this is done without confusion.

IMPORTANCE OF THINKING IN PRODUCTION CYCLES

It is therefore necessary, in handling production on this basis, properly to train and develop central control or schedule men to think in terms of production cycles and not in terms of individual operations. If this is not done uneconomical conditions will develop, due to the fact that one department will not be synchronized with another. Costly delays and inefficient machine layouts will result. All products, either standard or special, when placed on schedule are allotted a definite time for the completion of the job. The time set is based not only on the capacity of the equipment but also the experience of the labor available.

Table 10

CLASSIFICATION OF DUTIES OF PRODUCTION CONTROL PERSONNEL, PLANTS NO. 1 AND 2

Foremen	In charge of division.
Head supervisors	In charge of control functions and personnel—several departments.
Plant Nos. 1 and 2—central control	Contact, master schedules and materials control.
Chief dispatcher	In charge of station—all shifts.
Senior dispatcher	In charge of shift—local schedules and dispatching.
Junior dispatcher	Floor dispatching and time-keeping.
Stockkeeper	Handling and dispatching stock in and out of storage points.
Scalemen	Weighers.
Secretary and clerical	Typists, clerical work and checkers.
Clerical and messenger	Clerical work and messenger service.

Occasionally additional equipment may be required, due to the quantity of work on hand. When this occasion arises, the merchandise distribution department is promptly notified in order that the sales department may be informed that it may be necessary for the branch and consumer to wait longer than usual on the particular product affected.

In order correctly to synchronize the flow of material through the plant, it is necessary for all machines to work to a time standard scientifically determined. Therefore, generally speaking, all work is scheduled by machine-minutes. The capacity of the machine is based on piece-work rates.

PRODUCTION CONTROL HALVED OUR IN-PROCESS TIME

By B. HERBERT LUSTBERG

Of Lustberg, Nast and Company, Incorporated, New York

THE change in business to hand-to-mouth buying has affected us just as it has the great majority of businesses. No longer do our customers buy six months' supply of merchandise at one order, giving us two to four months to make delivery. Instead, they send in a month's order and want it in three weeks. And like every manufacturing organization which has faced this condition, we have had to adjust our methods and policies accordingly.

At first it seemed rather a disadvantage. Instead of the big orders which permit putting work through the factories in large lots in a leisurely way, we had a myriad of small orders, all wanted practically day before yesterday.

Selling in the quantities required by customers since 1921 has, of course, its seamy side. It is a nuisance to handle smaller orders, to bill and ship and handle through the account books 5 and 10 dozen where 48 and 100 dozen were the established unit. But we have found that as a result of the changes which this shift in our customers' buying habits made necessary, we have reaped some very well worthwhile results.

The first important requisite was a definite knowledge of how long it takes to put an order through the factories. Formerly we considered three and one-half weeks a very satisfactory in-process period—when we bothered to consider at all such an irrelevant subject. We did not, as it happens, worry much about in-process times, except for the occasional rush order. It did not occur to us to worry about rate of turnover or that sort of thing. That was all very well for the retailer, we figured. As for us, we were manufacturers and such topics were not for such as us.

With the smaller lots, it became evident that we must exert a close control on production. We must put every lot through in what would previously have been the time given us on a double-rush order. If we could not, why—some one else could and would.

So we undertook a system of production scheduling, dispatching, and control which would keep us posted at all times on where a lot stood in any of our plants scattered from Maine to Pennsylvania.

And we undertook to watch the progress of each order so that it would surely get through in time for the agreed delivery.

The particular mechanism which we employed for this purpose, and which for that matter we still employ in somewhat improved shape, is relatively unimportant. In its essentials it consists of a plan-board with a specific space representing each cutting order, and ruled so that the dates on which the lot enters and leaves each department can be entered. A cutting ticket goes to the factory specifying the schedule which must be observed to get the lot through on time. The rest of the mechanism consists of a tickler file, maintained on my desk, so that each lot comes up for attention on the day when it should pass through a department. If it has not been reported finished by next day's mail, a reminder goes through to the factory in question—and the lot gets a little extra attention until it has again caught up to schedule.

There is no use going into the minute details of this method. The method itself is unimportant, and an equally satisfactory method could be designed by almost any manufacturing executive to meet the requirements of his production. But the results, originally unlooked for by us, which have resulted from and grown out of this production control are of a sort which should interest almost any manufacturer. It is the principle that matters.

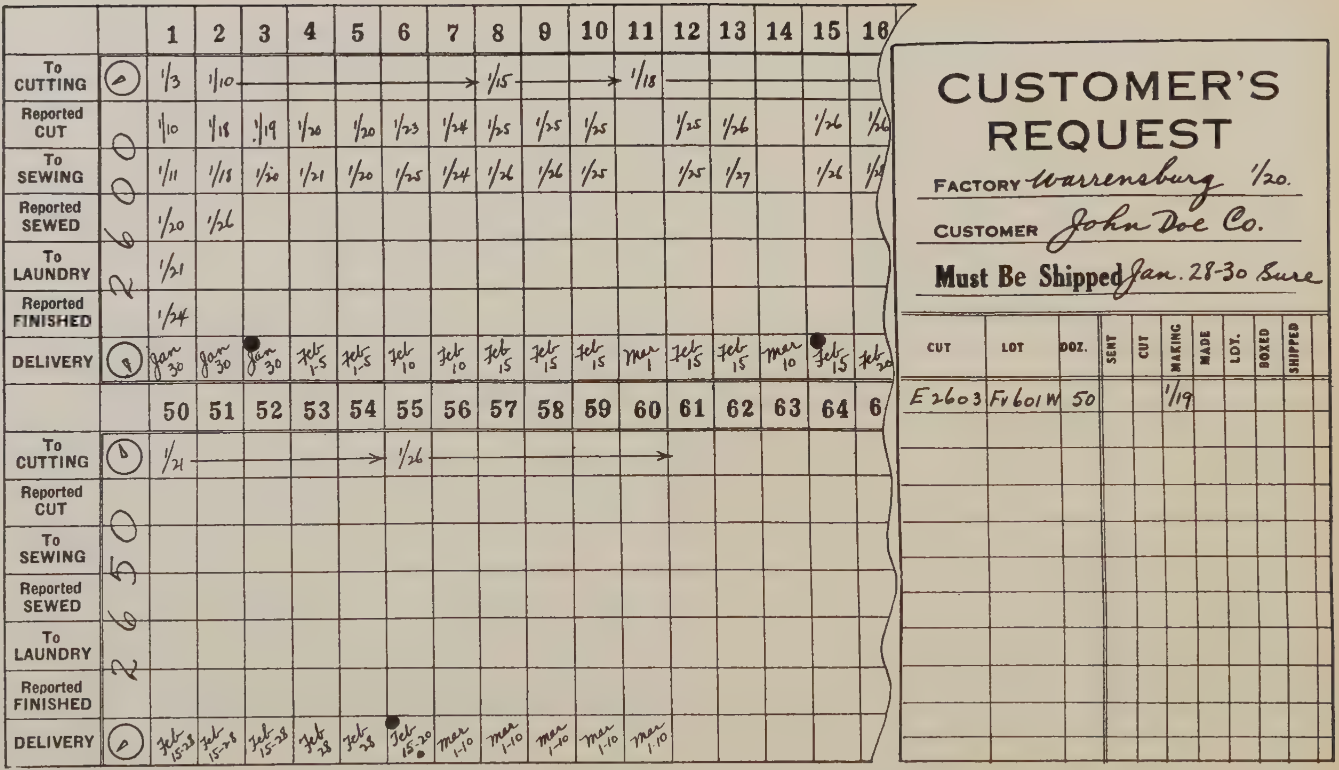
We have reduced our average time in process 50 per cent. The job which used to come through the sewing department in a little more than three weeks is now ready in about 10 days. And in one of our plants, which we have used almost as a laboratory to develop our production control and refine it, we have cut the time to 8 working-days or less.

Recently I visited another manufacturer in our field—our line of product happens to be shirts. "How long does it take you to put an order through your sewing departments?" he inquired in the course of our swapping experiences and ideas.

"Ten days," I told him, not wishing to cite our one plant which has our average time beaten.

"Ten days," he repeated after me, musingly. Then, "Oh, I mean for regular lots, not rush orders!"

It took several minutes of active explaining to convince him—and, mind you, his is a well-managed business for our line—that I was talking about regular lots. As a matter of fact, I suppose we could rush a medium-sized order through in five working-days in



		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
To CUTTING		1/3	1/10						1/15			1/18					
Reported CUT		1/10	1/18	1/19	1/20	1/20	1/23	1/24	1/25	1/25	1/25		1/25	1/26		1/26	1/26
To SEWING	0	1/11	1/18	1/20	1/21	1/20	1/25	1/24	1/26	1/26	1/25		1/25	1/27		1/26	1/2
Reported SEWED	0	1/20	1/26														
To LAUNDRY	6	1/21															
Reported FINISHED	2	1/24															
DELIVERY		Jan 30	Jan 30	● Jan 30	Feb 1-5	Feb 1-5	Feb 10	Feb 10	Feb 15	Feb 15	Feb 15	Mar 1	Feb 15	Feb 15	Mar 10	● Feb 15	Feb 20
		50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	6
To CUTTING		1/21					1/26										
Reported CUT	0																
To SEWING	5																
Reported SEWED	6																
To LAUNDRY	2																
Reported FINISHED																	
DELIVERY		Feb 15-28	Feb 15-28	Feb 15-28	Feb 28	Feb 28	● Feb 15-20	Mar 1-10	Mar 1-10	Mar 1-10	Mar 1-10	Mar 1-10					

CUSTOMER'S REQUEST

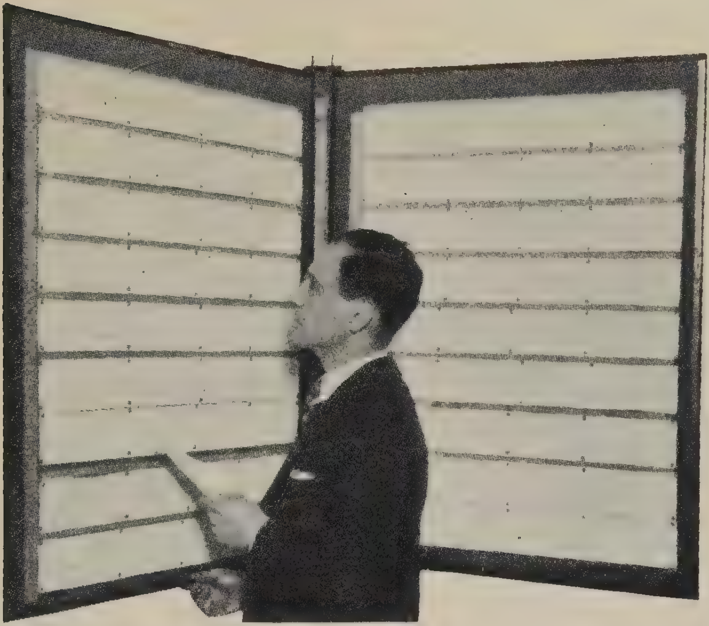
FACTORY Warrensburg 1/20.

CUSTOMER John Doe Co.

Must Be Shipped Jan. 28-30 Sure

CUT	LOT	DOZ.	SENT	CUT	MAKING	MADE	LDY.	BOXED	SHIPPED
E2603	Fr601W	50			1/19				

FIGURE 48. *The author on page 189 is referring to the plan-board, a part of which is shown in close-up detail. In his hand is a request slip (shown in detail, at the right) which applies against one of the lots on the plan-board. Where work orders are urgent, a red mark in the delivery space calls attention to the fact*



our star plant, if we had to. We had much rather not do it, for one fact our production control has disclosed to us beyond any possibility of reasonable argument is that rush orders delay regular production far more than the differential of time in favor of the rush orders. It is hard to gain much time for a single order by favoring it; but favoring one slows down the rest.

Our increased speed in process has of course materially reduced the number of rush jobs. Every order goes through, in regular course, in ample time, without rush.

We were not concerned, as it happens, with any attempt at economy when we started in to exercise a close control on our production. We were simply setting out to reduce the in-process time so that we might meet our short-delivery schedules and not lose trade by disappointing customers. But we have found, to our pleasurable surprise, that reducing the time in process has brought with it a goodly number of incidental advantages to our profit statement in addition to accomplishing our primary purpose.

Take the subject, or subheading, of reducing our work in process. This is both a method and a result. Cutting down the quantity of work in the shops permits performing the manufacturing operations more quickly on the orders in process. And speeding up the rate of progress of jobs through the manufacturing departments has as its inevitable concomitant reducing the quantity of work which is stacked up awaiting operations.

In shirt manufacture, the unit in which work starts through the plant and continues until it is finished is the bundle. When a cutter cuts out a batch of shirts from the piece goods, he does not cut a single garment at a time. Instead, he lays out the fabric on the cutting table a good many ply deep, cutting with either a knife or a machine.

When he has cut out his batch of shirts, the pieces are tied together in bundles: so many fronts, so many backs, so many sleeves, and so on. Next the bundles go to the various sewing departments where specialized operators perform the various operations. One group of girls makes fronts, another backs, and so forth. Finally in what might be termed an assembly line, the various bundles of finished parts meet and are sewed together into shirts.

One result which our scheduling for production control has brought is that it pointed unmistakably to the necessity for putting bundles through in exact rotation. The bundles are numbered serially as they leave the cutting department. And, as would probably happen in the ordinary course of handling between departments, bundles numbers 1, 2, 3, and 4 are all carried away together. When these bundles are separated for the different operations, bundle 1 of sleeves might get first attention in the sleeve-making section; bundle 2 of fronts might happen to be on top and hence start through the sewing operation; bundle 4 of backs might get into process first of the backs, and so forth.

When bundle 1 of sleeves reaches the assembly, then, it must be laid aside to await the other bundles bearing the same number. Bundle 2 of fronts, arriving at the same time, must await the companion bundles of its lot. So it is with the other two bundles. The operators who sew the parts together may conceivably have to sit idle until the whole assortment of bundles is finished. Then they are swamped with work to get the three or four bundles out immediately.

In common with most shirt manufacturers, we used to let this very thing happen. What worry was it of ours? Either the girls, who all worked on piece-rates, had to sit around waiting for work, or we had to have a surplus of work in operation. This, of course, was before we began paying attention to production control.

Now we avoid this difficulty by an iron-clad rule that bundles must be sent through each process in exact rotation. No deviation is permitted except on the occasional rush order which we have to favor, because of some special condition. Failure to follow exact rotation calls for disciplinary action. And the result has been a reduction in work in process.

If I have given the impression, by an earlier reference to our planning and scheduling mechanism, that this is all there is to decreasing the in-process time, let me hasten to correct myself. It goes back of this, of course. But, like reducing the amount of work and speeding the sequence of operations, it is a little difficult to say which of these measures is a cause and which is a result. They interact one on the other.

As soon as a manufacturer undertakes to exercise close production control, if our experience may be taken as a criterion, he is likely to find that his departments are out of balance. The cutting room is seldom the bottle neck, because it requires a comparatively small personnel and can be increased considerably by adding a cutter or two. The laundry is not likely to slow down output, for one presser can press in a day the week's output of a sewing-machine operator. It was our observation when we came to study it that work was ordinarily slowed down because of maladjustment in the sewing-room. If we could turn out more sleeves in a day than we could backs and fronts, then obviously the finishing would have to be slowed down to the rate of the slowest sewing operation. We altered this difficulty by increasing the number of machines where they were needed to take up the slack.

Another trouble comes from absenteeism, something which occurs every day in some degree, at some times in excessive degree, and which cannot easily be controlled. If a flu epidemic strikes the community, the general perverseness of things seems to decree that it will strike one section more heavily than another. And if no provision is made to compensate for this, the whole factory's pace must drop to the pace of the stricken section.

In a large plant, a flying squad of employees trained in every operation is an excellent remedy. We, however, have a number of comparatively small plants. In such a factory, the cost of a flying squad is likely to be high.

An unfortunate characteristic of our branch of the needle trades is that a large proportion of the women employees, especially in the smaller towns where shirt factories are located to the best advantage, have home duties to which they must give some attention. Almost as important as the money it pays is the opportunity the job yields for meeting the other womenfolks and talking over the day's gossip. As some cynic has remarked, if there was a daily newspaper they wouldn't need jobs.

Consequently they are as independent as the traditional hog on ice. Ask such an operator to work on another job than her own and she is quite likely to retort, "If there isn't work at my regular job, I'll just go home for the day." And to this remark the harassed forelady has no adequate comeback.

We have got around this difficulty by making it worth their while to learn and perform the other jobs. After trying various plans, we have pretty well standardized on paying an operator on other than her regular job the regular piece-rate plus a rate per hour. And while we do not always have the good fortune to have enough trained operators in the full section to fill the places in the short section, we can usually manage well enough by transferring girls from operation B to perform in the absentees' places on operation A, and then can make up the balance by moving some from operations C and D to even up on B. The total cost of this transferring in all our plants was, in 1927, just under two cents a dozen on our total production—a sizable sum of money, of course, but much less than if we had had to slow down production each time we were shorthanded.

Another method which has increased our speed of output has been separating the functions of production and quality control which were formerly concentrated in the department forelady. The average supervisor is lopsided; she is either a specialist on quality or on getting the work turned out. Most of ours, both because of our type of manufacture and because they are older women, leaned to an emphasis on quality.

This suits us perfectly, because we want quality stressed. But under current conditions we must also keep production under control. So in most instances we detailed the established forelady to the job of quality supervisor, and made a production supervisor of some younger woman with the energy and drive to see that the work is turned out. The production supervisor checks up each section

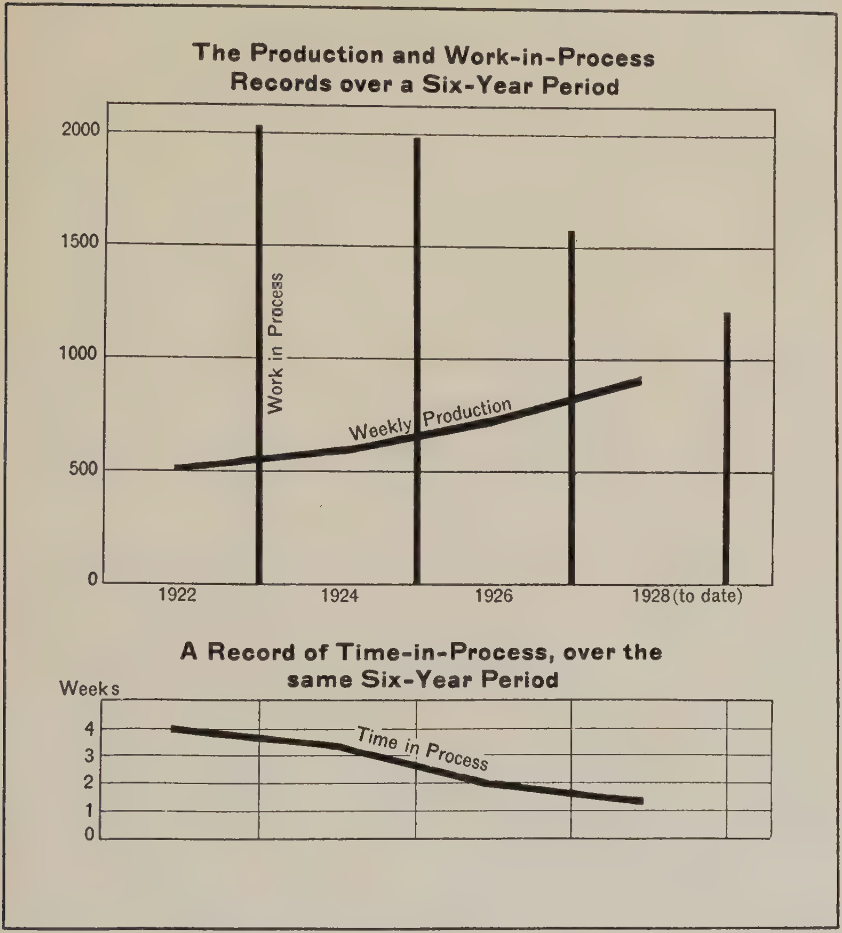


FIGURE 49. *These graphs show the reduction of inventory by reducing the amount of work in process; the increase in weekly production; and the reduction of in-process time at one of the plants of this company*

four times a day to see how it is progressing with the work. If she discovers that one section is falling behind the rest, she first switches operators. Then if she still is behind in this section at the end of the day, instead of letting the girls go at 5 o'clock she holds them until 6, or a shorter overtime period if less than an hour's output is needed to catch up. We pay no increased rate for overtime of an hour or less, and the operators do not enjoy overtime work because most of them want to get home to prepare their husbands' dinners.

So we have comparatively little difficulty now with one section slacking up and delaying the whole factory.

This whole question of production control is, after all, a matter of management. Except for the occasional hour of overtime, the individual operator in our plants does not realize that it has taken place. She knows that she has fewer delays waiting for work, that she works more steadily, is laid off less often. She gets more money in her pay envelope because she has turned out more work. But she has not been required to speed up or turn out more pieces per hour during the hours she works. Nobody has experienced any discomfort from it anywhere along the line.

Yet work flows through now in one-half or one-third the time that formerly was considered standard. Because much less work is lying around the factory for far shorter periods of time, the shirts are cleaner. They suffer less damage. We have fewer mix-ups. It works out like the accepted principle of the clean desk-top. If nothing accumulates on the desk, no time is spent looking through heaps of papers for this or that. With no work piled up in the manufacturing departments, we waste no time searching for some particular bundle.

This confusion used to entail a really serious problem. We make our goods for the jobbing trade, which orders in comparatively larger units than do retailers. On the other hand, practically every job is to individual specifications, and we must ship in the most economical units. If, as used to happen right along, a small bundle was mislaid in the factory and was not found and finished until after the shipment had gone to the customer, we had to throw these shirts into odds and ends. For a jobber, accustomed to receiving shirts in large shipments, does not welcome the duty of receiving and checking, handling, accounting and paying for a small shipment of a half-dozen shirts which comes tagging along after his order has been otherwise filled.

We know that production control has saved us a lot of grief, that it has cut our inventory of work in process, has decreased many of the charges which formerly were accepted as unpalatable necessities incidental to the business. We know that it has enabled us to meet the changed conditions of trade so that our manufacturing fits hand-to-mouth buying without a hitch and our production meets our short-delivery schedules with very few slip-ups. And it has enabled us to increase our production tremendously as our volume has increased, with a minimum of trouble.

But when it comes to estimating what it has meant in dollars and cents in the profit account, we strike a snag. It is a good deal like taking medicine. We know that previously we had certain ailments. We have every reason to think that these ailments would have become more serious without treatment. Just how much of the recorded improvement is due to the medicine we took—production control—and how much to other factors we do not know.

I do not think, at that, we should like to discontinue the treatment!

PURCHASE METHODS OF THE CADILLAC COMPANY

By E. F. RAUSS

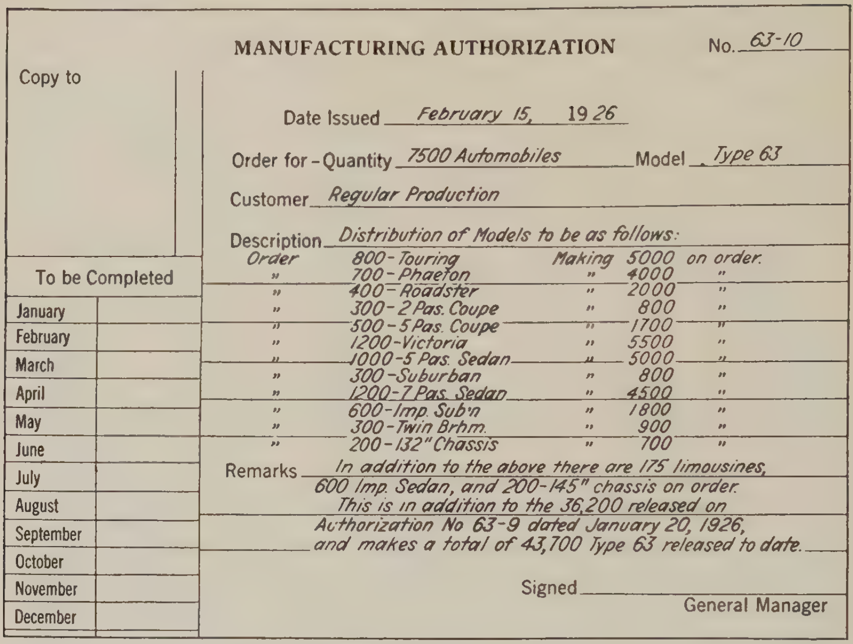
Supervisor of Economies, Cadillac Motor Car Company

IN THE automobile industry the need is generally realized for a correct adjustment of purchasing to anticipated sales requirements. The importance of this co-ordination was particularly emphasized in 1920 when failure to approximate the purchases of material and parts closely with probable sales led to excessive inventories and had much to do with the difficulties that confronted business for quite some time thereafter.

As a result of these experiences it is natural that the industry should have energetically attacked the purchasing problem. Methods were needed which would establish an alignment as nearly perfect as possible between commitments for purchases and actual requirements likely to present themselves from the sales angle over a given period in the future.

GENERAL MOTORS' PLAN

In the General Motors Corporation, efforts have therefore been made to create barometers for guidance in adjustment of these two factors. Extensive detailed analyses are made of general business activities in all markets. In addition, care is taken to record actual sales by the factories of the corporation to distributors and dealers and also to list the number of sales made at retail. Studies are then made of the relationship between the wholesale and retail transactions with a view to determine the likely demand by dealers for new cars in the near future. This data helps the executives con-



MANUFACTURING AUTHORIZATION No. 63-10

Copy to

Date Issued February 15, 1926

Order for-Quantity 7500 Automobiles Model Type 63

Customer Regular Production

Description Distribution of Models to be as follows:

Order	800-Touring	Making	5000	on order.
"	700-Phaeton	"	4000	"
"	400-Roadster	"	2000	"
"	300-2 Pas. Coupe	"	800	"
"	500-5 Pas. Coupe	"	1700	"
"	1200-Victoria	"	5500	"
"	1000-5 Pas. Sedan	"	5000	"
"	300-Suburban	"	800	"
"	1200-7 Pas. Sedan	"	4500	"
"	600-Imp. Sub'n	"	1800	"
"	300-Twin Brhm.	"	900	"
"	200-132" Chassis	"	700	"

Remarks In addition to the above there are 175 limousines, 600 Imp. Sedan, and 200-145" chassis on order. This is in addition to the 36,200 released on Authorization No 63-9 dated January 20, 1926, and makes a total of 43,700 Type 63 released to date.

Signed ______ General Manager

To be Completed	
January	
February	
March	
April	
May	
June	
July	
August	
September	
October	
November	
December	

Figure 50. *Manufacturing authorization*

siderably in mapping out their respective policies on purchases and in thus keeping operations on a sound basis.

As regards the Cadillac Motor Car Company, a definite procedure has been worked out whereby all commitments—both standard and forward—may be controlled under authorized production schedules.

The president of the company is called upon to approve the total number of motor cars to be manufactured. To that end a "Manufacturing Authorization," Figure 50, is used. It indicates the quantity of each model to be put into production. Figures showing the total cumulative number of cars already on order under each model are also given to facilitate general supervision of developments. Indication is also given of months in which cars must be completed. Copies of the manufacturing authorization are sent to all the executives and superintendents who will be affected by subsequent phases in manufacturing of cars indicated in the form.

It might be mentioned that on the sample form of the manufacturing authorization, as well as on the other forms, figures given are for illustrative purposes only, and are not those from actual records.

PRODUCTION SCHEDULE FOR MOTOR CARS TO CADILLAC PLANNING & PURCHASE DEPT.

Authorization No. 10, Schedule No. 12

	132-INCH STANDARD									132-INCH DE LUXE											
	TOUR	PHAE	ROAD	VICT	LAND	7-SED	7-I-SE	COACH	2-CPE	5-CPE	5-SED	SUB	IM SU	T. BRO	LIMO	132 CH	138 CH	145 CH	145 CH	IMP. SED.	TOTAL
Cumulative thru May	3650	3450	780	940	40	790			398	1720	3440	4680	1970	300	275	420			200	500	23553
June	200	200	320	780	200	500			290	200	400	200	100	50	100	0			70	100	3710
Total	3848	3650	1100	1720	240	1290			680	1920	3840	4880	2070	350	375	420			270	600	27263
October	200	300	200	400	400	600			100	100	100	500	100	50	40	90	100		600	100	3980
Total	5000	5000	0	2000	1200	1500			1000	2500	6100	5500	4000	700	800	600	100		400	900	37300
Cumulative Release	5600	5700	600	2900	1700	4000			1200	2600	6900	5400	4900	900	1000	700	200		500	1200	43700

FIGURE 51. *Production schedule for motor cars*

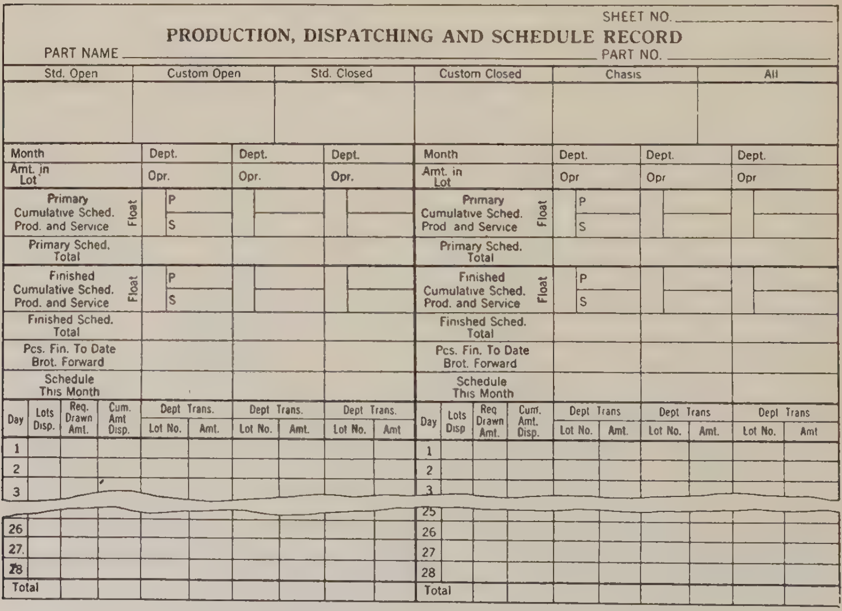
On the basis of the manufacturing authorization, the "Production Schedule" (Figure 51) for the various kinds of models is prepared by the production manager in co-operation with the sales department which bases recommendations on experience data from distributors and dealers.

The sales department has special facilities to keep informed on market conditions in view of the constant contacts it maintains through its field representative with the distributors and dealers.

The production schedule definitely indicates the quantities of different models to be manufactured and the periods in which the work is to be completed so as to fit in best with demands of sales department.

LAYING OUT OF MANUFACTURING PROGRAM

For the guidance of all executives, superintendents and foremen in the Cadillac organization, manufacturing programs are made up by the planning department in the form of "Production Dispatching and Schedule Records" (Figure 52). These are prepared for each part, sub-assembly and assembly, and indicate the quantity to be



SHEET NO. ____

PRODUCTION, DISPATCHING AND SCHEDULE RECORD

PART NAME ____ PART NO. ____

Std. Open	Custom Open	Std. Closed	Custom Closed	Chasis	All

		Dept.		Dept.		Dept.	
Month		Dept.		Dept.		Dept.	
Amt. in Lot		Opr.		Opr.		Opr.	
Primary Cumulative Sched. Prod. and Service	Float		P S				
Primary Sched. Total							
Finished Cumulative Sched. Prod. and Service	Float		P S				
Finished Sched. Total							
Pcs. Fin. To Date Brot. Forward							
Schedule This Month							

Day	Lots Disp.	Req. Drawn Amt.	Cum. Amt Disp.	Dept Trans.		Dept Trans.		Dept Trans.	
				Lot No.	Amt.	Lot No.	Amt.	Lot No.	Amt
1									
2									
3									
26									
27									
28									
Total									

		Dept.		Dept.		Dept.	
Month		Dept.		Dept.		Dept.	
Amt. in Lot		Opr		Opr		Opr	
Primary Cumulative Sched. Prod and Service	Float		P S				
Primary Sched. Total							
Finished Cumulative Sched. Prod. and Service	Float		P S				
Finished Sched. Total							
Pcs. Fin. To Date Brot. Forward							
Schedule This Month							

Day	Lots Disp	Req Drawn Amt.	Cum. Amt. Disp.	Dept Trans		Dept Trans		Dept Trans	
				Lot No.	Amt.	Lot No.	Amt.	Lot No.	Amt
1									
2									
3									
25									
26									
27									
28									
Total									

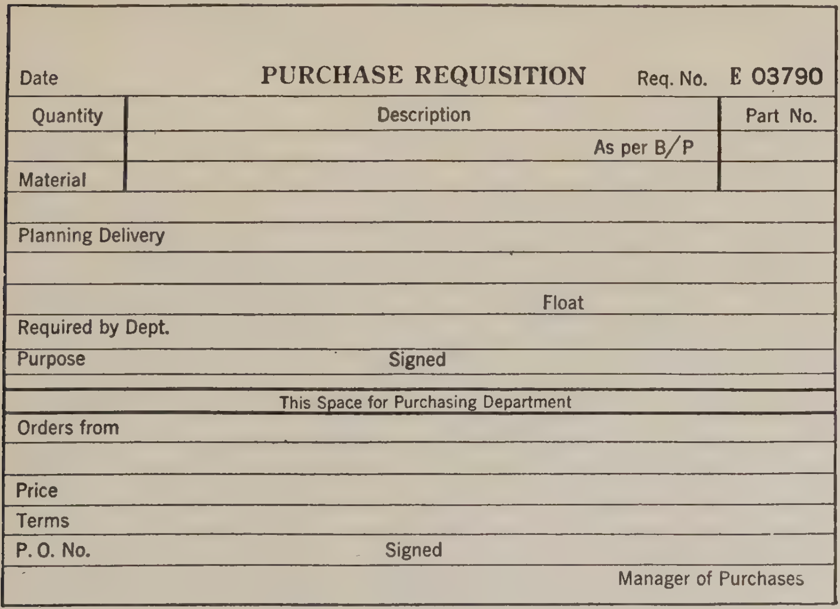
FIGURE 52. *Production dispatching and schedule record*

built each month, based upon the time required to manufacture them, and generally referred to as the float.

The planning department, after completing the production dispatching and schedule record, issues the "Purchase Requisitions" (Figure 53) for the materials required. The quantity of material ordered is based upon the production schedule for motor cars, Figure 51, and the time required for the float is obtained from the production, dispatching and schedule record, Figure 52.

The purchase requisition contains full data regarding the quantity of the product to be bought, and the material of which it is to be made. A blue print is attached and the number of the part indicated. Details regarding date of delivery, purpose for which purchased product is to serve, float, and department making the requisition are included. Space in the form is left for particulars that the purchasing department will have to insert pertaining to supplier, price, terms and similar matters.

"Purchase Orders" (Figure 54) are then authorized by the manager of purchases on basis of the approved purchase requisitions. The scheduling of materials to be bought is planned by the pur-



Date PURCHASE REQUISITION Req. No. E 03790

Quantity	Description	Part No.
	As per B/P	
Material		

Planning Delivery

Float

Required by Dept.

Purpose Signed

This Space for Purchasing Department

Orders from

Price

Terms

P. O. No. Signed

Manager of Purchases

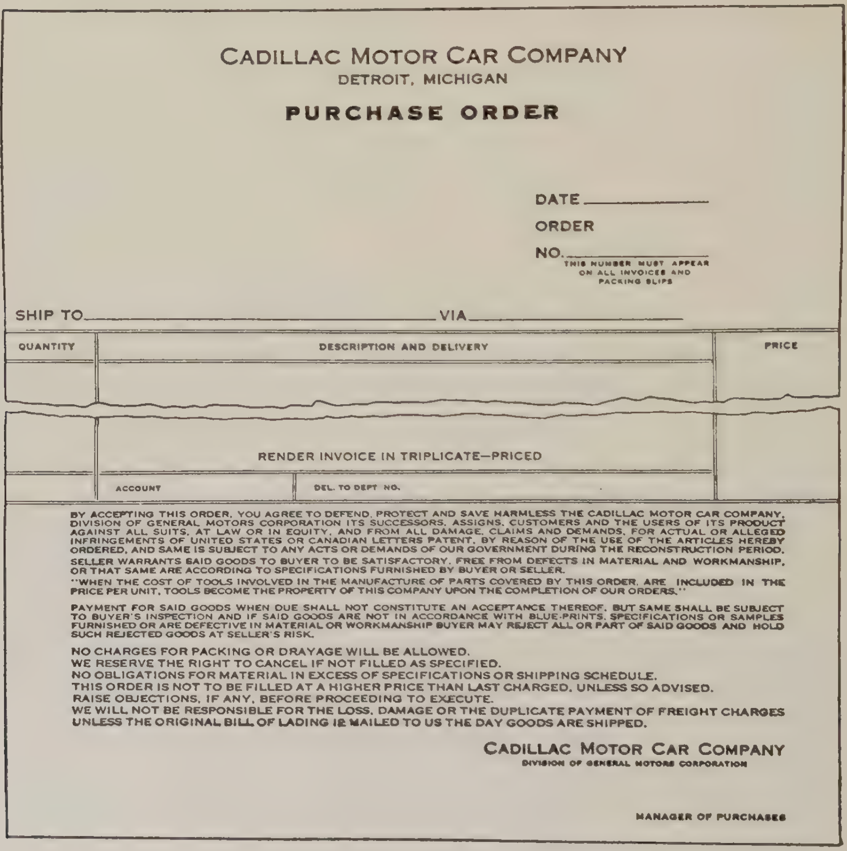
FIGURE 53. *Purchase requisition*

chasing department on basis of the "Float Chart" (Figure 55) developed by the planning department.

FLOAT CHARTS

In the float charts, the schedule is subdivided to allow for varying periods of time that may be involved in the different manufacturing operations, ranging from two-week floats to as many as 15-week floats. Purchases are accordingly made on a program to synchronize deliveries with production requirements as they are to develop for the different materials during the course of manufacturing.

An exception is made in the shipping schedules for bodies purchased from the Fisher Body Division of the General Motors Cor-



CADILLAC MOTOR CAR COMPANY
DETROIT, MICHIGAN

PURCHASE ORDER

DATE ____________
ORDER
NO. ____________
THIS NUMBER MUST APPEAR ON ALL INVOICES AND PACKING SLIPS

SHIP TO ______________________ VIA ______________

QUANTITY	DESCRIPTION AND DELIVERY	PRICE
	RENDER INVOICE IN TRIPLICATE—PRICED	
	ACCOUNT DEL. TO DEPT NO.	

BY ACCEPTING THIS ORDER, YOU AGREE TO DEFEND, PROTECT AND SAVE HARMLESS THE CADILLAC MOTOR CAR COMPANY, DIVISION OF GENERAL MOTORS CORPORATION ITS SUCCESSORS, ASSIGNS, CUSTOMERS AND THE USERS OF ITS PRODUCT AGAINST ALL SUITS, AT LAW OR IN EQUITY, AND FROM ALL DAMAGE, CLAIMS AND DEMANDS, FOR ACTUAL OR ALLEGED INFRINGEMENTS OF UNITED STATES OR CANADIAN LETTERS PATENT, BY REASON OF THE USE OF THE ARTICLES HEREBY ORDERED, AND SAME IS SUBJECT TO ANY ACTS OR DEMANDS OF OUR GOVERNMENT DURING THE RECONSTRUCTION PERIOD.

SELLER WARRANTS SAID GOODS TO BUYER TO BE SATISFACTORY, FREE FROM DEFECTS IN MATERIAL AND WORKMANSHIP, OR THAT SAME ARE ACCORDING TO SPECIFICATIONS FURNISHED BY BUYER OR SELLER.

"WHEN THE COST OF TOOLS INVOLVED IN THE MANUFACTURE OF PARTS COVERED BY THIS ORDER, ARE INCLUDED IN THE PRICE PER UNIT, TOOLS BECOME THE PROPERTY OF THIS COMPANY UPON THE COMPLETION OF OUR ORDERS."

PAYMENT FOR SAID GOODS WHEN DUE SHALL NOT CONSTITUTE AN ACCEPTANCE THEREOF, BUT SAME SHALL BE SUBJECT TO BUYER'S INSPECTION AND IF SAID GOODS ARE NOT IN ACCORDANCE WITH BLUE-PRINTS, SPECIFICATIONS OR SAMPLES FURNISHED OR ARE DEFECTIVE IN MATERIAL OR WORKMANSHIP BUYER MAY REJECT ALL OR PART OF SAID GOODS AND HOLD SUCH REJECTED GOODS AT SELLER'S RISK.

NO CHARGES FOR PACKING OR DRAYAGE WILL BE ALLOWED.
WE RESERVE THE RIGHT TO CANCEL IF NOT FILLED AS SPECIFIED.
NO OBLIGATIONS FOR MATERIAL IN EXCESS OF SPECIFICATIONS OR SHIPPING SCHEDULE.
THIS ORDER IS NOT TO BE FILLED AT A HIGHER PRICE THAN LAST CHARGED, UNLESS SO ADVISED.
RAISE OBJECTIONS, IF ANY, BEFORE PROCEEDING TO EXECUTE.
WE WILL NOT BE RESPONSIBLE FOR THE LOSS, DAMAGE OR THE DUPLICATE PAYMENT OF FREIGHT CHARGES UNLESS THE ORIGINAL BILL OF LADING IS MAILED TO US THE DAY GOODS ARE SHIPPED.

CADILLAC MOTOR CAR COMPANY
DIVISION OF GENERAL MOTORS CORPORATION

MANAGER OF PURCHASES

FIGURE 54. *Purchase order form*

PRODUCTION SCHEDULE NO.________ **AUTHORIZATION NO.________**
Figures Based on 1 All **Date________**

SCHEDULE								SHOULD BE DUE AFTER______INCL ______NOT SCHED'D
2 Wks. Float	Bal. Due							
3 Wks. Float	Bal. Due							
13 Wks. Float	Bal. Due							
14 Wks. Float	Bal. Due							
15 Wks. Float	Bal. Due							

FIGURE 55. *Float chart*

poration. From production schedule for motor cars, the production manager prepares a "Production and Shipping Schedule for Bodies" (Figure 56). This comprises all bodies that are to be received during each month from the Fisher Body Corporation.

It indicates the number of bodies required for the different models and classes of chasses. Not only are the monthly requirements shown, but cumulative figures are also inserted each month in all columns to provide quick analysis of total current requirement of the different body types.

BODY TRIM AND COLOR

A special procedure is followed as regards specifications which pertain to body trim and color finish. These specifications are controlled by the manager of the sales specifications department.

When the manufacturing authorization is approved, the executives of the Fisher Body Corporation and the Cadillac Motor Car Company, including representatives of the engineering, sales and purchase departments, hold a meeting and make selections of the various patterns of upholstery fabrics they believe to be most suitable and attractive for Cadillac bodies.

After the trimming fabrics have been selected, the manager of the sales specifications department prepares the "Paint and Trim Specifications" (Figure 57) which authorizes the Fisher Body Corporation to complete a specified number of various types of custom bodies in certain trims and color finishes.

The specifications for the body trim and color finish for Cadillac standard bodies are also controlled by the manager of the sales

PRODUCTION AND SHIPPING SCHEDULE FOR BODIES TO FISHER BODY CORPORATION

Authorization No. 10, Schedule No. 12

2-28-26

	132-INCH STANDARD								CSTM	132-INCH DE LUXE						COWLS					
	TOUR	PHAE	ROAD	VICT	LAND	7-SED	7-I-SE	COACH	2-CPE	5-CPE	5-SED	SUB	IM SU	T. BRO	IMP. SED.	132 CH	138 CH	145 CH	SPEC	LIMO.	TOTAL
Cumulative thru May	0	0	0	1500	700	2000					To be completed for car shipments by July 1										4200
June	100	200	50	400	0	500															1250
Total	100	200	50	1900	700	2500			500	3000	4000	3000	2000	200	500					150	18800
October	200	400	300	300	200	500			100	300	400	200	300	0	100		100				3400
Total	500	1000	700	3000	1500	3500			800	4000	5000	4000	3000	1000	1000		300				29300
Cumulative Release	700	1200	900	3200	1800	4000			900	4300	6000	4700	3300	1200	1100		500				33800

FIGURE 56. *Production and shipping schedule for bodies*

specifications department. His authorization to Fisher Body Corporation is transmitted in the form of a letter because there are specific patterns of upholstery fabrics and color finishes for the standard bodies.

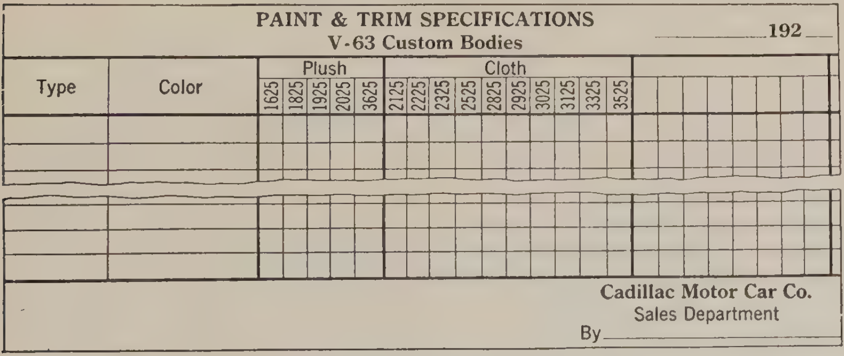
PURCHASING OF BODIES

From the production and shipping schedule for bodies, Figure 56, the planning department issues a regular purchase requisition form, Figure 53, for the various kinds of bodies required, and from this approved purchase requisition a regular purchase order form, Figure 54, is authorized by the manager of purchases.

In the past, it has been found, upon examination of the production schedules for motor cars and purchase orders for Fisher bodies, that never have more bodies been ordered than were actually required for the number of motor cars scheduled to be built, as released by the manufacturing authorization. In Table 11, given only for illustration and not containing actual data, is shown the reconciliation of the cumulative releases for motor cars, with the cumulative releases for Fisher bodies.

COMPARISON OF SCHEDULES

By examining a Fisher Body Corporation's Cadillac shipping schedule (Figure 58), to determine how closely it compares in cumulative totals with the production and shipping schedule for bodies, Figure 56, it is noticed that the difference in the cumulative totals on these two reports for month of September was 3,000 bodies. Such a difference is caused by the fact that after the Cadillac production schedule for bodies, Figure 56, has been prepared, it may

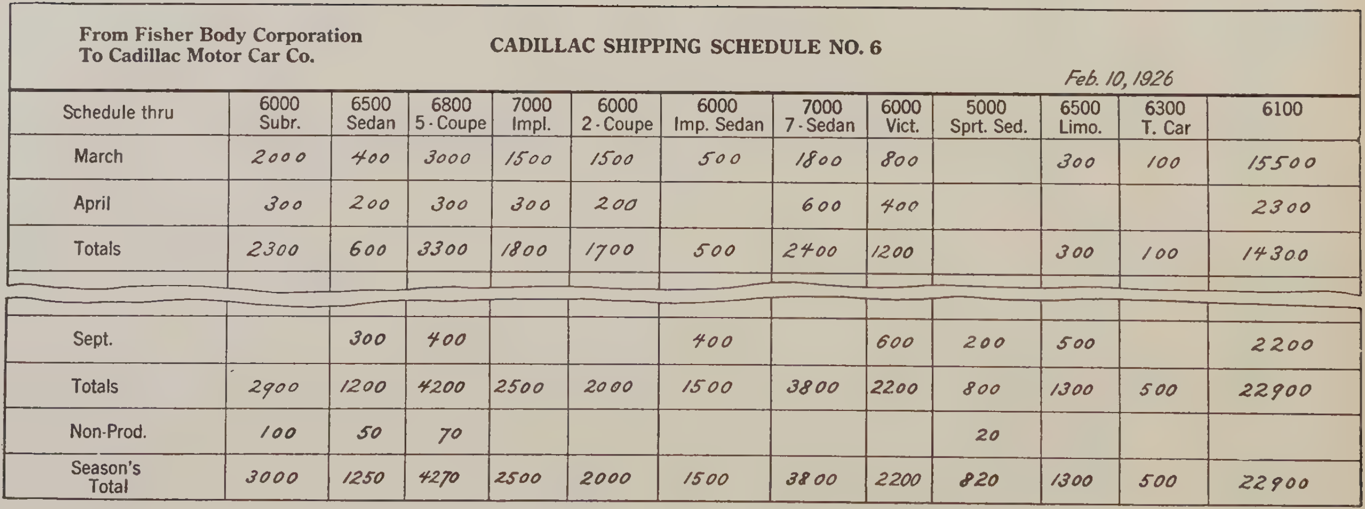


PAINT & TRIM SPECIFICATIONS
V-63 Custom Bodies
____________192___

Type	Color	Plush					Cloth																	
		1625	1825	1925	2025	3625	2125	2225	2325	2525	2825	2925	3025	3125	3325	3525								

Cadillac Motor Car Co.
Sales Department
By____________________

Figure 57. *Paint and trim specification*



From Fisher Body Corporation
To Cadillac Motor Car Co.

CADILLAC SHIPPING SCHEDULE NO. 6

Feb. 10, 1926

Schedule thru	6000 Subr.	6500 Sedan	6800 5-Coupe	7000 Impl.	6000 2-Coupe	6000 Imp. Sedan	7000 7-Sedan	6000 Vict.	5000 Sprt. Sed.	6500 Limo.	6300 T. Car	6100
March	2000	400	3000	1500	1500	500	1800	800		300	100	15500
April	300	200	300	300	200		600	400				2300
Totals	2300	600	3300	1800	1700	500	2400	1200		300	100	14300
Sept.		300	400			400		600	200	500		2200
Totals	2900	1200	4200	2500	2000	1500	3800	2200	800	1300	500	22900
Non-Prod.	100	50	70						20			
Season's Total	3000	1250	4270	2500	2000	1500	3800	2200	820	1300	500	22900

FIGURE 58. *Fisher Body Corporation's Cadillac shipping schedule*

be deemed advisable either to increase or reduce the schedule of bodies, due to business conditions.

To determine the actual elapsed time between the issuance of the purchase orders for bodies and the receiving dates, it is possible to make an examination of purchase orders for the bodies required in a release under a typical Manufacturing Authorization.

This examination may disclose postponements, beyond the time limit provided by the standard commitment plan, of the acceptance of a portion of the total bodies ordered. This condition comes about because of sudden and unforeseen fluctuations in business trends. At any particular time there may be a quantity of bodies yet to be received to complete the number under a certain manufacturing authorization, but delivery may be postponed due to some such unforeseen conditions. (Figure 59.)

TABLE 11

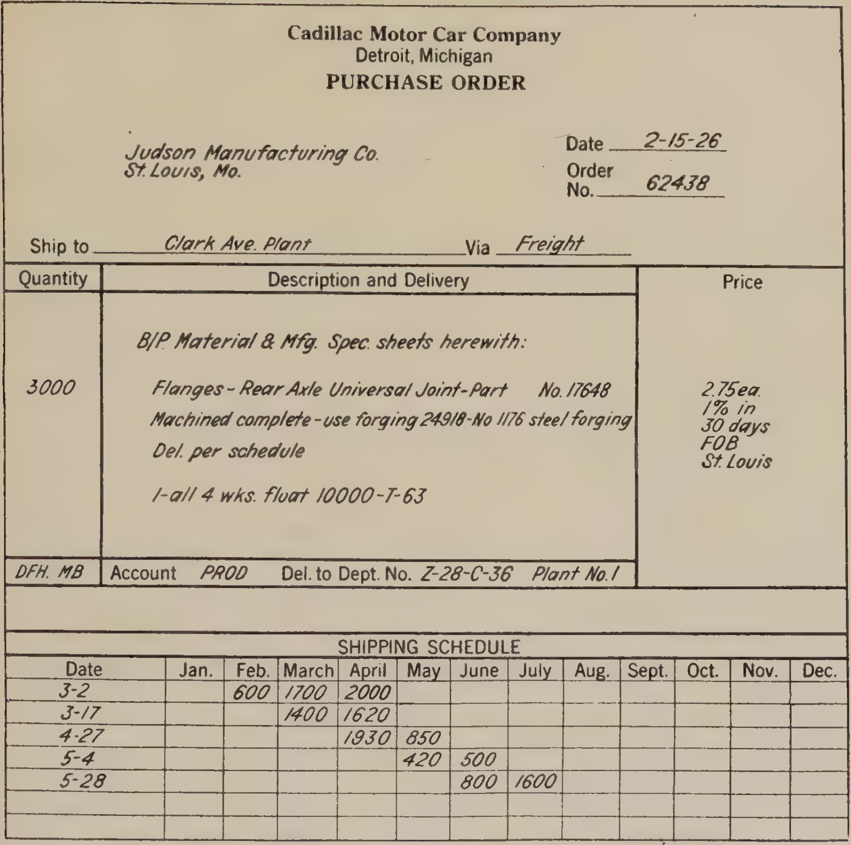
CHECK-UP OF CUMULATIVE RELEASES FOR MOTOR CARS AND FOR BODIES

May 22, 1924, cumulative total on production schedule for motor cars, per Figure 51			00,000
Deductions:			
Open bodies built by Cadillac Motor Car Company:			
Touring	0,000		
Phaetons	0,000		
Roadsters	000	0,000	
Chassis:			
132 inches	000		
138 inches	000	000	0,000
Cumulative total of releases on production schedule for:			
Fisher bodies (including 100 short sill cowls) per Figure 56			00,000
Deductions:			
Contemplating cancellation:			
Touring Bodies	000		
Phaeton Bodies			
Town Bodies			
Victoria Bodies	000		0,000
September 30, 1926, cumulative total on schedule for bodies. Figure 56	0,000		
October, 1926, schedule for bodies not shown on Figure 56	0,000		
			00,000
			00,000

SCHEDULE OF BODIES ORDERED AND RECEIVED FROM FISHER BODY CORPORATION
Authorization No. 10. Dated Feb. 15, 1926

	Tour.	Phae.	Road.	Vict.	5 Pass. Sedan Standard	7 Pass. Sedan Standard	2 Pass. Coupe Custom	5 Pass. Coupe Custom	5 Pass. Sedan Custom	Sub'n. Custom	Imp. Sub'n. Custom	Town Car Custom	Total
No. and kind of Bodies ordered. *Mar. 15, 1926*	*600*	*400*	*700*	*900*	*600*	*1000*	*500*	*400*	*700*	*800*	*300*	*400*	*7300*
Bodies rec'd during:													
Mar. *1926*				*100*						*200*		*25*	*325*
Apr. *1926*								*100*	*150*	*50*	*50*	*50*	*400*
May *1926*	*100*		*50*			*300*	*150*		*50*	*100*		*40*	*790*
June *1926*					*100*	*50*				*100*		*60*	*310*
July *1926*		*100*		*300*	*100*	*200*	*50*	*50*	*150*		*50*		*1000*
Aug. *1926*					*200*		*100*		*100*	*50*		*30*	*480*
Sept. *1926*			*200*	*100*		*200*	*200*			*150*	*50*		*900*
Oct. *1926*			*100*	*200*	*100*	*100*		*50*	*200*	*50*		*70*	*870*
Nov. *1926*		*150*						*50*		*100*	*50*	*20*	*370*
Dec. *1926*	*100*		*200*			*150*		*100*	*50*			*40*	*640*
Total Bodies Rec'd.	*200*	*250*	*550*	*700*	*500*	*1000*	*500*	*350*	*700*	*800*	*200*	*335*	*6085*
Total to be Rec'd.	*400*	*150*	*150*	*200*	*100*	*0*	*0*	*50*	*0*	*0*	*100*	*65*	*1215*
Cancelled			*25*	*75*									*100*
Totals	*600*	*400*	*700*	*900*	*600*	*1000*	*500*	*400*	*700*	*800*	*300*	*400*	*7300*

FIGURE 59. *Schedule of bodies ordered and received*



Cadillac Motor Car Company
Detroit, Michigan
PURCHASE ORDER

Judson Manufacturing Co.
St. Louis, Mo.

Date 2-15-26
Order No. 62438

Ship to Clark Ave. Plant Via Freight

Quantity	Description and Delivery	Price
3000	B/P Material & Mfg. Spec. sheets herewith: Flanges - Rear Axle Universal Joint - Part No. 17648 Machined complete - use forging 24918-No 1176 steel forging Del. per schedule 1-all 4 wks. float 10000-T-63	2.75 ea. 1% in 30 days FOB St. Louis
DFH. MB	Account PROD Del. to Dept. No. Z-28-C-36 Plant No. 1	

SHIPPING SCHEDULE

Date	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
3-2		600	1700	2000								
3-17			1400	1620								
4-27				1930	850							
5-4					420	500						
5-28						800	1600					

FIGURE 60. *Purchase order with delivery schedule*

The difficult problem of correctly adjusting the manufacturing authorization to requirements subsequently developed has been experienced also in connection with materials other than bodies in different instances selected for test examination.

Purchase orders (Figure 60) are placed with the different suppliers for certain quantities of parts, such as differentials, horns and flanges. In the original shipping schedules for these items, as indicated in one case in Figure 60, it was shown that the suppliers had been requested to deliver the ordered quantities of materials within the time limits as provided by the standard commitment plan. However, the acceptance of a portion of this material was postponed beyond the time limit of the standard commitment, an action

SCHEDULE OF COMMITMENTS

A Commitment consists of any direct or indirect obligation other than one absolutely cancellable at Division's option, without loss, covering the purchase of material of any kind which, when invoiced, becomes a part of Inventory.

A Commitment is a Commitment when it is made, not when it is due.

Each Operating Division shall indicate in Columns 3 to 6 inclusive the various items listed as 1 to 14 in Column 1 It shall also indicate in Column 2 the previous month's actual figures of items 1 to 14 in Column 1.

No estimates are required on lines 4, 5, 6, 7, 11 and 12 in Columns 4, 5, and 6.

	2	Estimated By Months			
1	Previous Month Actual	3	4	5	6
Total Commitments beginning peroid					
1. Outside					
2. Allied					
3. Totals (lines 1 and 2)					
Commitments during peroid					
4. Standard outside			—	—	—
5. Standard allied			—	—	—
6. Forward outside			—	—	—
7. Forward allied			—	—	—
8. Totals (lines 3, 4, 5, 6, 7)					
Commitments invoiced during peroid					
9. Outside					
10. Allied					
Commitments cancelled					
11. Outside			—	—	—
12. Allied			—	—	—
13. Totals (lines 9, 10, 11, 12)					
14. Total Commitments end of period (line 8 less 13)					

FIGURE 61. *Schedule of commitments*

deemed advisable on the basis of business conditions prevailing at the period.

VARIATIONS FROM SCHEDULES

An examination of the detailed records covering these test items, conveyed the information that they were typical examples of a practice that necessarily developed as result of the causes interlinked with general business, and that had been established in connection with ordering, shipping schedules, and shipping records for parts, sub-assemblies and assemblies.

In view of the importance of purchases on the general conducting of business, not only from the production viewpoint but from the financial as well, steps are taken to summarize all commitments for ready comparison in a special form (Figure 61). Thus the figures shown in column 2, under the heading "Previous Month Actual" give the cumulative totals of actual valuations obtained from purchase orders under 14 items. The subdivision of items on which this information is given covers total commitments at beginning of pediod, commitments during period and commitments cancelled. Further subdivisions under each of these headings are given to show commitments placed with outside and allied suppliers.

The figures in column 3 of the schedule of commitments for the current month for the various 14 items in column 1, are the cumulative totals of the actual values of the purchase orders up to and including the 20th of the month and the last 10 days of the previous month.

DISTRIBUTION OF COMMITMENTS

The total commitment at the end of the current month, as shown on line 14, column 3, is spread on an estimated basis over the three succeeding months, as shown in columns 4, 5 and 6 of items 9 and 10 in column 1.

This form, therefore, tends to give a bird's eye view of all commitments actually made and anticipated during a period in the future. It enables the executive to have immediate knowledge of trends as regards commitments. The importance of this close control by an executive can be best illustrated by the significance attached to a commitment, which has been defined as any direct or indirect obligation other than one absolutely cancelled at division's option without loss, covering the purchase of material of any kind which, when received becomes a part of the inventory.

THE CASE OF MANAGEMENT VS. EXCESSIVE INVENTORIES

By H. SOPER

Vice-President and General Manager, Greenfield Tap & Die Corporation, Greenfield, Massachusetts

DURING the War, the Greenfield Tap & Die Corporation, like so many other manufacturing plants, increased its force by many hundreds of workers to take care of war-time contracts. We erected restaurants and canteens to feed them. Since the War, these buildings have been standing empty—at least, they were empty up to a year ago. Since then we have been glad to make use of them to house the ever-increasing quantity of tote boxes which we found we did not need for our work in process once we began to get full control of our inventories. In addition to filling this space, we have thousands of tote boxes in a disused plant. In our tap plant alone the pile is 10 or 12 feet high, 30 feet long, and 15 feet wide. All of these boxes, up to the time we started to get things in hand, were filled with work in process.

Since the unit value of our product is comparatively high, you may imagine the savings we have found possible. When we decided to clean up, it took nine laborers a couple of weeks or so to remove the boxes from the plants. Today, the only work in process is on the machines or immediately ahead of them. We have no piles of partly finished work, gathering dust and dirt in odd corners, only to be disturbed by a frantic chaser hunting for an order put in process six months before—which may or may not be the same lot Jim Smith recollects spoiling three months ago!

We used to have an office filled with clerks who received hurry-up calls from the sales department, consulted yellowing files to see when the work was commenced, sent chasers into the plant to locate it, and when found, kept elaborate charts which showed the day-to-day progress of the order being rushed. That is, it *was* day-to-day progress until some order believed to be more urgent pushed it aside—when it was again forgotten until another frantic call once more pushed it into the main stream, to be finally completed.

Lest the reader gain the impression that this plant presented a horrible example of "How not to do it," I want to say right here that the system employed was no worse, and in many respects was better, than that of most plants of this type, for, in spite of all its

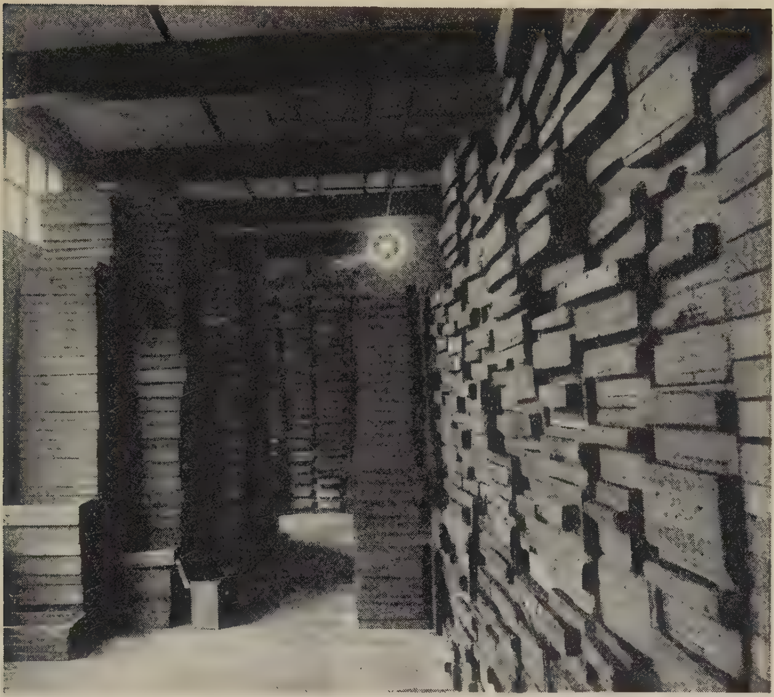


FIGURE 62. *Exhibit A—Imagine these boxes filled with work in process! They used to be. Sometimes enough work was piled up to keep a machine busy for weeks*

handicaps, the concern had forged ahead to an outstanding position in its field.

While the tote boxes are a visible evidence of the amount by which the investment in work in process has been reduced, perhaps a more striking impression is obtained by comparing production cycles before and after the clean-up. Last May it took five months on an average to put an order through the plant. By November, this period had been reduced to less than two weeks.

Before going further into details of how this striking result has been accomplished, it may be of interest to note that the experience which brought about these changes was obtained in an entirely different field—that of toilet ware, such as combs, brushes, mirrors. A few years ago, it took three or four months to produce the sheet material, and another three or four months to fabricate toilet articles, which were subject to changes of style in women's fashions

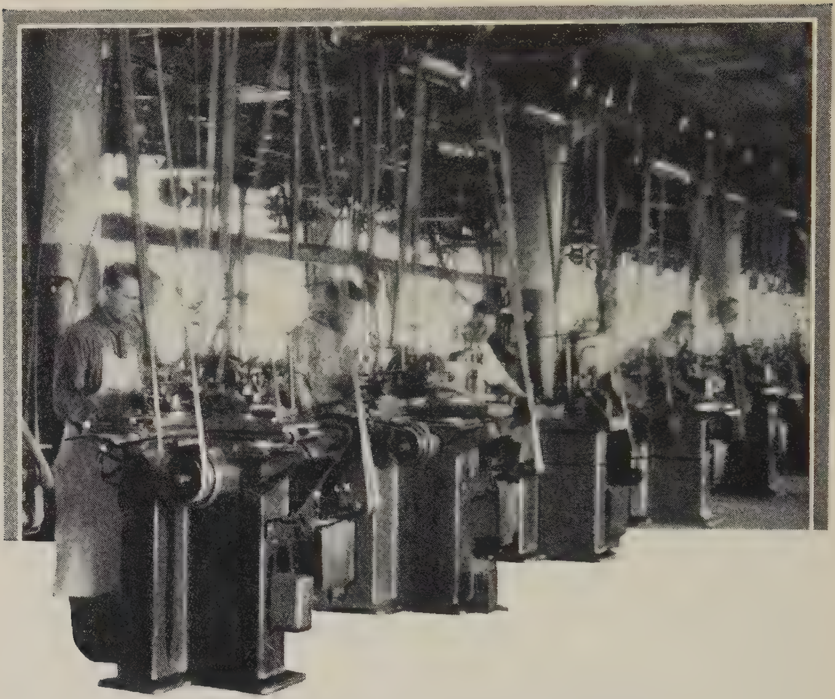


FIGURE 63. *Exhibit B—No army of stock chasers is needed to get out production. The only work in process is actually at the machines*

and which were produced in dozens of combinations of colors, finishes and shapes. Since the manufacturing period was longer than the time it took the fashion experts to decree whether women would use green or blue hair brushes, each season's production was a gamble, and stocks on hand at the end of the selling season had either to be scrapped or thrown on the market for what they would fetch. After many months of experiment and trial, a means of control was developed which eventually resulted in producing regular goods in ten days instead of four months, and special designs in one day instead of the two or three months previously required.

After a thorough investigation, there seemed to be no good reason why the lessons so painfully and laboriously learned in the manufacture of women's novelties could not be successfully applied in the manufacture of small steel tools. So we set out to get the facts.

We found that an immense number of different varieties of articles had to be kept in stock—almost 20,000 of them. There was no possibility of standardizing on a few sizes and letting the rest go, since the most expert salesman cannot convince a customer who wants a ½-inch tap that he could probably use two ¼-inch taps just as well. Again, we found that, owing to the precision with which small tools have to be made, the most economical lot usually ran into four figures. Since some small tools sell for several dollars apiece, a finished stock running into millions of dollars was therefore necessary to make quick deliveries and keep customers satisfied. If we could find a way to reduce the time it took to replace our finished stock, we could reduce not only our inventory of work in process, but also the finished stock itself. Obviously, if it took six months to manufacture goods, we had to have at all times a six months' stock on hand in order not to run out before replacements arrived, whereas if we could replace our stock in one month, we should need to carry only one month's supply in our finished inventory. With this in mind, we looked over the manufacturing system, and found that it could be represented diagramattically by a funnel into which a lot of orders were thrown at the top, got choked on the way down, with only a thin trickle coming out at the bottom—while a lot of chasers poked sticks up the neck of the funnel in the hope that some of the urgently needed items might be persuaded to drop through sooner than expected.

The first question we asked ourselves was: In view of the jam that exists in the plant, do we need right at this time to manufacture everything that is now in process? To answer that question we took our inventory sheets and set down against each item the average monthly sales for a period long enough to give us a correct picture of the situation. Dividing the average sales by the inventory on hand gave us the average month's supply of stock on hand. This provided illuminating figures. While many fast-moving items had practically nothing ahead, at other times we found almost ten years' supply on hand. Knowing approximately how long it was taking to replace finished goods taken from stock, we ear-marked a sufficient quantity for our needs and called this "active stock"; the balance was thrown into a separate account and called "inactive stock."

Leaving the inventories for the moment, we returned to our production figures and ascertained the ratio of returns and defective goods to our total production for each class of goods. (We wanted to be reasonably sure that our plans for working with smaller stocks would not be thrown out of gear by excessive rejections.) We then

Figure 64. *Exhibit C—Lot sizes strike the mean between excessive set-up costs caused by short orders and excessive delivery times due to long runs*

obtained three other figures as a guide by which we could measure any progress made in our system of planning: (1) ratio of unfilled orders to monthly sales; (2) average age of unfilled orders from customers; (3) average age of production orders in the factory.

The next step was thoroughly to analyze the equipment and other production facilities we had to work with, so that we might lay down definite times in which the work could be done. This involved: (1) an analysis of plant capacity by classes of tools; and (2) an analysis of the product with regard to the delivery requirements of customers or required by market conditions, particularly where the quantities were so small that regular lot sizes might result in delayed deliveries.

By comparing set-up times and production times with these two analyses, we were able to set lot sizes that would strike the mean between excessive set-up costs caused by short orders, and excessive delivery times due to long runs.

Our next move was to take an inventory of work in process. Where we had a sufficient quantity of finished stock on hand, we tagged the lots in the factory, removed them from process, and placed them in intermediate storerooms. This left nothing on the shop floors but goods that were needed fairly urgently. Large lots were subdivided to suit machine times, in such a way that no lot would take more than two days to go through the slowest operation—the intention being to re-combine the small lots so that several of them could be handled at once in the faster operations. We were now beginning to get a clearer picture of the work on hand in each department and, by consultation with the foreman, were able to determine what steps would be necessary to even up the work between departments. Some had to work short time, while in others overtime and night shifts were necessary, until we finally had the work in process more or less balanced.

As soon as we knew the approximate amount of work ahead in the starting departments, we re-scheduled our material on order in accordance with the time when it would be required—our previous practice having been to order the material when the production orders were placed, irrespective of whether or not the machine capacity could take care of cutting up the raw material. We now had a condition where the goods required for regular stock were just as urgently needed as the goods made to a customer's special order and so, except in extraordinary circumstances, we did not permit one order to go ahead of another; everything had to be taken as it came, the foreman being checked by the number of days' work ahead of him. This brought out the interesting fact that the delay on many orders was due to an incorrect piecework price, since under the former congested conditions men were able to work on orders that paid well and could leave alone those on which the piecework price was comparatively low. Conditions previously suspected were thus brought to light and attended to by the management.

Foremen were now required to send to the superintendent's office a daily list of the orders which had not moved within a given period, together with reasons why they could not be worked on. The former order-chasers were put to work remedying conditions which caused such stoppages. As the amount of work in each department grew less, the time a lot was permitted to remain in it was shortened, until now each lot is expected to move out within a day, else it appears on the foreman's report. These reports were posted on cards in the

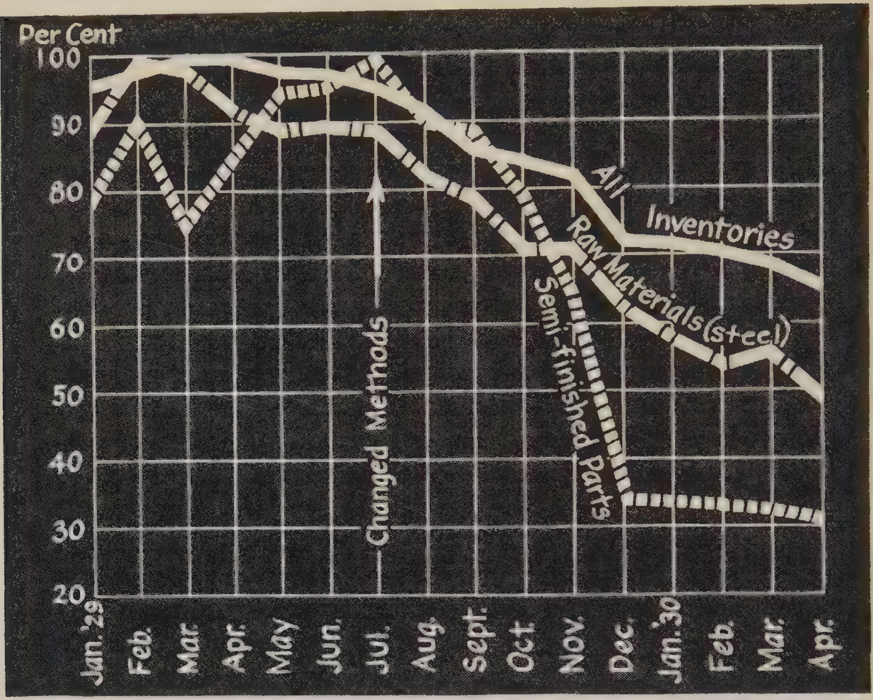


FIGURE 65. *Exhibit D—Graphic representation of what happened to inventories when average production time was cut from five months to two weeks*

superintendent's office, and one girl is able to take care of the work previously performed by six or more clerks.

All that remained was to refine the system and work energetically on the bottle-necks disclosed by the foremen's reports. The result was that within six months the average time taken for each lot was reduced from about five months to less than two weeks.

After the November slump, this time gradually increased to about three weeks, since in some operations there was not sufficient work to keep operators working daily so that certain departments were shut down a number of days each week. This, however, did not disturb the general plan, because those responsible for making delivery promises knew at all times how many days were regularly being taken, and could make promises accordingly. Furthermore, when the foremen were thoroughly accustomed to the idea of having work in process in their departments for a minimum time only, they were personally able to supervise the pushing of some "extra special" orders, without getting tangled up with their regular production.

The stocks in the intermediate storerooms, which were first filled when the departments were cleaned up, were gradually fed back into the production stream, the preceding departments being slowed up accordingly, until they finally became wholly absorbed and the intermediate storerooms discontinued.

The process of inventory reduction is a continuing one, because, as the time taken to replace stocks is reduced, the quantity it is necessary to carry on hand in the finished storeroom is correspondingly reduced. Only goods of the latest manufacture are carried on hand and full advantage can be taken of improvements, whereas previously a change in product necessitated inventory losses of a considerable sum, either by reason of selling out the old stocks at reduced prices, or by carrying them on hand until finally they had to be scrapped.

PURCHASING FOR A FAST RATE OF TURNOVER IN THE PLANT

By C. W. NASH
President, The Nash Motors Company, Kenosha, Wisconsin

WITH the small profit margins available today, and assuming that costs and expenses have been trimmed to a minimum, there remains but one opportunity for increasing the annual net earnings: more rapid turnover of working capital. I do not feel that we shall see marked price reductions in the coming months; but instead possibly a demand for a greater refinement of product, which is in effect the same. This means that management attention must be directed, with keener application than in the past, to ways of converting inventory into dollars speedily. To gauge the turnover, balance it with sagacious purchasing, means a piling up of small profits constantly recurring through the year. How is this to be done? We believe by adequate control of inventory. And this in turn may in the last analysis be summarized thus: watch demand. In our manufacturing management we use three words: Watch Dealer Demand. There is no better starting point than a careful and continued survey of the buying trend as reflected in the dealer body.

It is not many years since the control of purchasing was a hap-

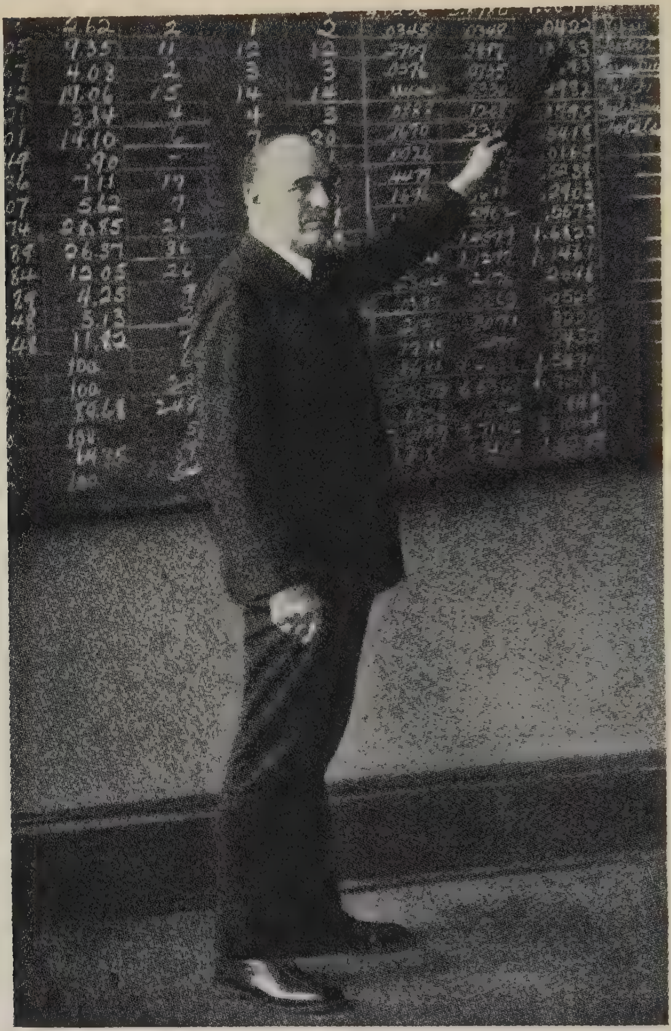


FIGURE 66. *"We schedule our purchase budget quarterly in conference of the heads of our purchasing department, the men responsible for production, the sales managers, and our general officers . . . it summarizes the collective observation and experience of all of us who are tremendously concerned that the schedule prove a correct forecast"*

hazard affair, to which attention was given only at periods of actual physical inventory, annually or semi-annually. Buying in the interim often became a matter of one man's guess.

My observation of the method in use for handling finished stocks by the large agricultural implement companies in earlier days, laid the groundwork for our present policy in purchasing for rapid turnover. I found that these companies carried a minimum of finished stock at factory, but depended instead on the ability of their branch managers with warehouse stocks of implements placed throughout the country, to predict sales and thus control production.

Purchase control in these companies was, to an extent, decentralized; they were taking into account the forecast of a group of men —guessing possibly; at all events it was not one man's guess, but many.

At that time, however, the control of inventory and its relation to rate of production was considered little. Large stocks were considered an evidence of responsibility. But in my experience with companies whose management had been intrusted to me, and in my observation of other business organizations, it long ago became apparent that methods for control of purchase and inventory were receiving far less attention than their importance demanded. Capital lying idle pays no dividends, and every dollar tied up in excess stocks can be regarded only as lost profits. Yet instances were not uncommon where companies continued to pay interest on money borrowed and converted into raw stock which lay untouched for months in warehouse or storeroom.

Some years ago on assuming the management of an automobile manufacturing company I found this condition of overstock prevailing to an extent that was not only a distinct source of lost profits but also a menace to the very existence of the business. For example, those in charge of the repair-parts stock-rooms in the branches of this company were responsible to no one in the factory organization as to the sum total of parts carried. The resultant accumulation of excess parts was appalling.

I took vigorous steps to improve the situation. At the end of the year following, the repair-parts item had been reduced one-third for the entire chain of branch stocks.

Factory inventory has in a good many plants duplicated these old-fashioned conditions. Not so with us. Our factory layouts have been planned to permit the routing of raw stock from unloading dock or yard storage to presses, forge, or machine-shop, the processed material all converging at the beginning of the assembly line.

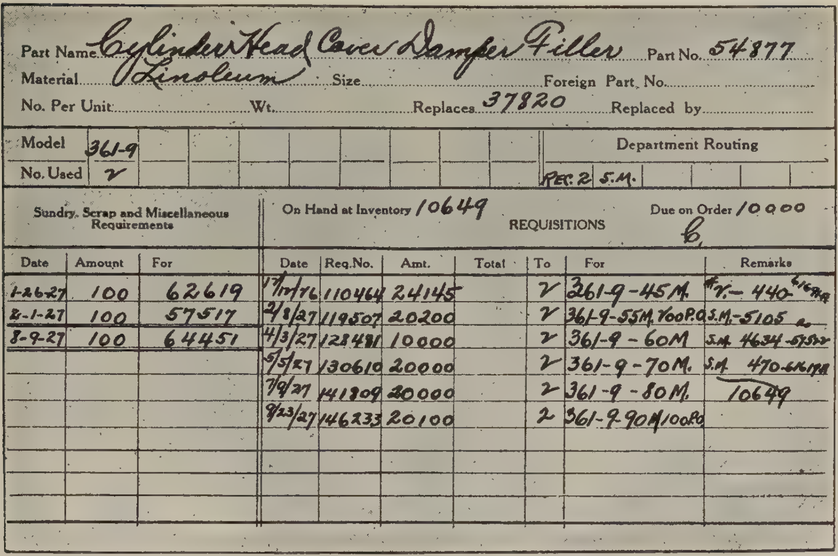
The goods in process at the end of any working-day are only the contents of the department trucks and such material as is left on the conveyor rollers.

Here again is emphasized the multiplication of profits through the speed-up in turnover resulting from a low, yet adequate inventory. From the beginning of the assembly line, the car moves forward rapidly to completion and is then ready for road test and shipment. This is a vital factor in turnover of manufacturing capital. It is in effect both reducing our goods-in-process inventory, and, as it speeds up production, spreading overhead through an increased output.

Straight-line production, then, is one step toward adequate control of inventory—more rapid turnover. For the second step, of paramount importance, I must go back to my opening sentence and repeat: Watch Dealer Demand. There is no set formula by which to gauge sales and so control production. At best it is only a guess, or, if the word seems objectionable, a rough estimate. However, it is necessary to follow some procedure which will reduce the hazard of over- or under-production to a minimum.

If the naturally optimistic sales department is to be the sole guide, the plant may find its warehouses suddenly bulging with the finished product. The finance and purchasing departments often lean to conservatism. But they are all concerned, or should be, in the budgeting of purchases. In our business, and no doubt it is true of others, our sales are seasonal to some extent; they may be inconsistent with comparative periods, also. There are automobile manufacturers who have entered a new year with a good product and a history of record-smashing sales behind them in the previous twelvemonth, to find their market narrow suddenly, and sales unaccountably decline to a new level. In this, possibly the automobile industry shares with the millinery business the unique distinction of a business in which style changes constantly, and appearance is a prime consideration. There is danger in the budgeting of automobile production on past performance. How then are we to plan our purchase schedule?

We order for a period limited to 90 days, believing that this is the longest period for which we can safely forecast. We believe it unwise to carry stocks for estimated production over more extended periods. At times we may lose the advantage of a money-saving purchase for a long upswing, but the law of averages levels these "good buys" with others not so fortunate.



Part Name Cylinder Head Cover Damper Filler Part No. 54877
Material Linoleum Size Foreign Part No.
No. Per Unit Wt. Replaces 37820 Replaced by

										Department Routing					
Model	361-9														
No. Used	2									Rec. 2	S.M.				

Sundry, Scrap and Miscellaneous Requirements

On Hand at Inventory 10649 REQUISITIONS Due on Order 10000 6

Date	Amount	For	Date	Req. No.	Amt.	Total	To	For	Remarks
1-26-27	100	62619	11/10/26	110464	24145		2	361-9-45M.	#2.- 440 [illegible]
2-1-27	100	57517	2/8/27	119507	20200		2	361-9-55M. 400P.O.	S.M.-5105
8-9-27	100	64451	4/3/27	128481	10000		2	361-9-60M	S.M. 4634-[illegible]
			5/5/27	130610	20000		2	361-9-70M.	S.M. 470-[illegible]
			7/9/27	141809	20000		2	361-9-80M.	10649
			9/23/27	146233	20100		2	361-9-90M/100P.O.	

FIGURE 67. *"We purchase for a period limited to 90 days, believing that this is the longest period for which we can safely forecast. We believe it unwise to carry stocks for estimated production over more extended periods."*

We schedule our purchase budget quarterly in conference of the heads of our purchasing departments, the men responsible for production, the sales managers, and our general officers. The control of inventory is set by our joint decision at these conferences; it summarizes the collective observation and experience of all of us who are concerned that the schedule prove a correct forecast.

No one who sells through so-called "regular channels of distribution" can fail to recognize the dealer as an important factor in turnover. It is the dealer on whom we are dependent for the sale by which is released the capital tied up in our finished stock and with it the unit of gross profit. He furnishes the impetus which, if we take advantage of it, will keep inventory dollars rolling.

Controlling inventory on its mechanical side is not difficult. It calls for common sense. To purchase with consistent judgment, neglecting neither quality nor first cost, requires specialized knowledge; men must be trained, must have acumen to buy rightly. Controlled production, careful buying, are essentials, but they must be founded on alert, intelligent forecasting of demand, to serve their purpose and speed the rate of turnover.

The coming months will place before management new problems for solution. The trend will be toward quality, but with prices remaining at low levels. We must be alert to decrease costs by the installation of more efficient mechanical appliances; we must be more concerned with the competence of labor than at any previous time in the history of industry. The product placed before the consumer must have incorporated in it the refinements which good judgment and a vigilant survey of the field indicate that he demands.

Then, an adequate control of inventory through wise purchasing will function to a maximum of profit by the resultant speeding up of turnover.

INVENTORY CONTROL ON A HUNDRED FACTORY ROADS

By A. K. WEST
The Timken Roller Bearing Company, Canton, Ohio

TO those who like hard nuts to crack, the following problem is recommended. Design a simple and effective perpetual inventory for a steel mill engaged in quantity production of special alloy steels in a wide variety of shapes and sizes. To be more specific, assume that two basic kinds of steel are produced, open hearth and electric, and that the analysis is specified by the customer. Also that the shapes may be bars, rounds, rods, or tubes, and the sizes almost anything desired. Orders for specified alloys or shapes and sizes may range anywhere from one ton to several hundred tons. Assume also that the orderly progress of material through the necessary fabricating processes is the exception rather than the rule. These are the broad outlines of the problem. As to requirements, the system adopted must be fool-proof as far as segregation of the material composing individual orders is concerned, it must be accurate with regard to the progress of the material over the production route, and it must be flexible enough to provide for all sorts of unforeseen eventualities.

This may seem like a large order, but a solution is perfectly possible. To descend from the general to the particular, the problem is that which confronted the Timken Steel and Tube Company on the completion of its new mill, and the solution is the system which

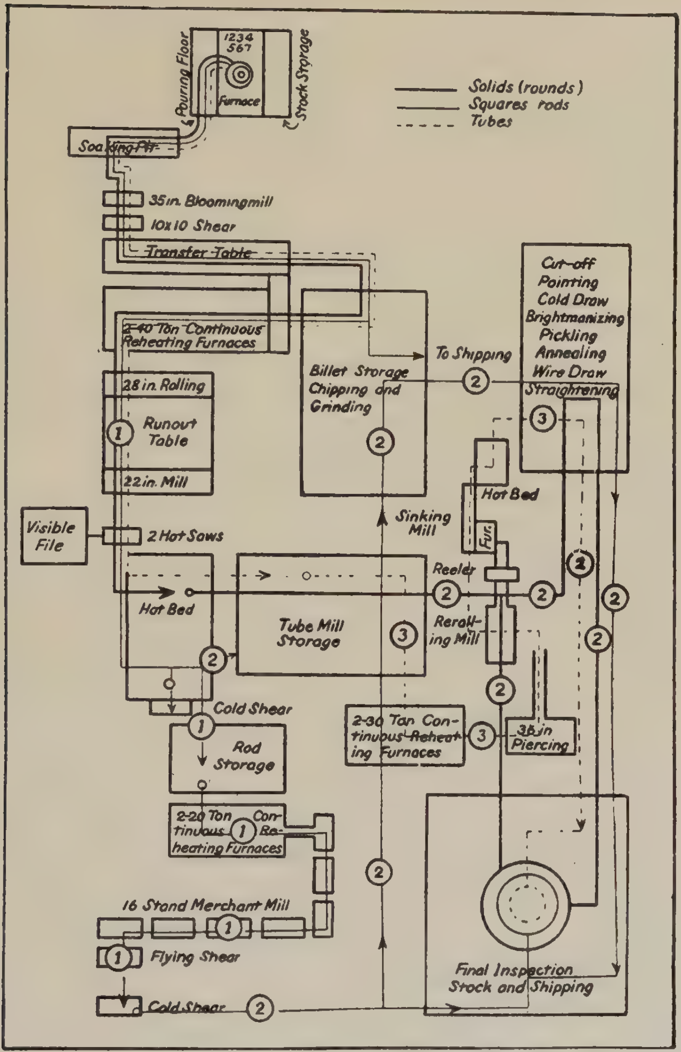

1234
567
Furnace
Pouring Floor
Stock Storage
Solids (rounds)
Squares rods
Tubes
Soaking Pit
35 in. Bloomingmill
10x10 Shear
Transfer Table
2-40 Ton Continuous Reheating Furnaces
28 in. Rolling
Runout Table
22 in. Mill
Visible File
2 Hot Saws
Hot Bed
Tube Mill Storage
Cold Shear
Rod Storage
2-20 Ton Continuous Reheating Furnaces
16 Stand Merchant Mill
Flying Shear
Cold Shear
Billet Storage Chipping and Grinding
To Shipping
Sinking Mill
Reeler
Rerolling Mill
Hot Bed
Fur.
2-30 Ton Continuous Reheating Furnaces
36 in Piercing
Cut-off
Pointing
Cold Draw
Brightmanizing
Pickling
Annealing
Wire Draw
Straightening
Final Inspection Stock and Shipping

FIGURE 68. *Although orderly progress is the exception rather than the rule, this flow chart shows the steel-mill highways followed by three main classes of product. The circled numbers indicate the points at which the control cards in the visible file are moved from (1) the "Not Rolled" panel to (2) subsequent process panels, or (3) to the "Tube Mill" panel*

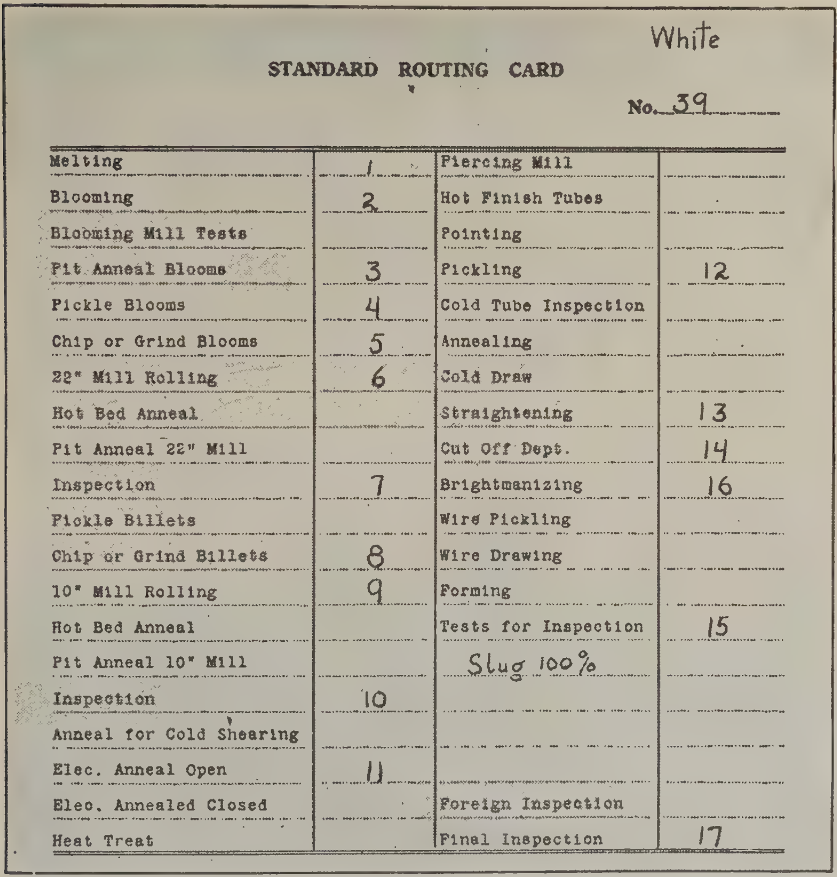
was actually adopted. Essentially it is based on a system of material identification similar, or nearly so, to that in vogue in most steel mills. It might be said that the chief complicating factor is the wide range in analyses that must be allowed for. Steels of different composition require radically different treatment, both before and after rolling, which necessitates their frequent diversion from the main channel of material flow. Also, this factor makes positive identification of material essential. Mixing steels of different compositions into a shipment that calls for a particular alloy is likely to have rather disastrous results for everyone concerned. Visually, at least, there is no way of telling them apart.

In planning the inventory control system the mill processes were divided into two categories, the first including all the fabricating processes proper, and the second including all the various treatments that the material goes through after fabrication. The reason for such a division is easily explained: until the material reaches its final form it is, under ordinary circumstances, moving too fast, and changing form too rapidly to be subject to a day-to-day control of any particular accuracy. Furthermore there is little chance of separation of the component parts of orders, so that a close check is hardly necessary. Once it has passed the last fabricating process, however, it does become a subject for close control, and accurate information as to its whereabouts at any particular time is of considerable importance. It is during these latter stages that the material making up an order is liable to become separated.

As a consequence, the control system may be considered as being two systems, as in fact it is, one taking over from the other at the point where the material leaves the fabrication processes. Perhaps a better way to put it would be to say that there is a master system and a subordinate one, the latter being the one that functions while the steel is being fabricated. However, the best way of explaining it is to describe the actual *modus operandi.*

When an order is received all the details concerning it; the customer, quantity, shape—that is tubes, rounds, etc.—size and analysis are transferred to a form called the work sheet. Based on the specifications, a route number is assigned to the order, according to the processes the material must go through. An order number is also assigned by which that particular lot will be known all the time it is in the mill.

To digress concerning the route numbers; these are assigned according to a group of route cards, a sample of which is shown in Figure 69. The cards show exactly what processes any particular order of steel must go through, including rolling, and heat or other treatment. Each card is given an arbitrary number for convenience, and there are enough of them so that practically any combination of processes liable to arise is represented. As a matter of fact there are more than a hundred possible routes, which gives some idea of the physical complications of the problem. And, if the specifications for the steel fit none of the established routes, there is space on the back of the work sheet for assigning special ones. A duplicate of



White

STANDARD ROUTING CARD

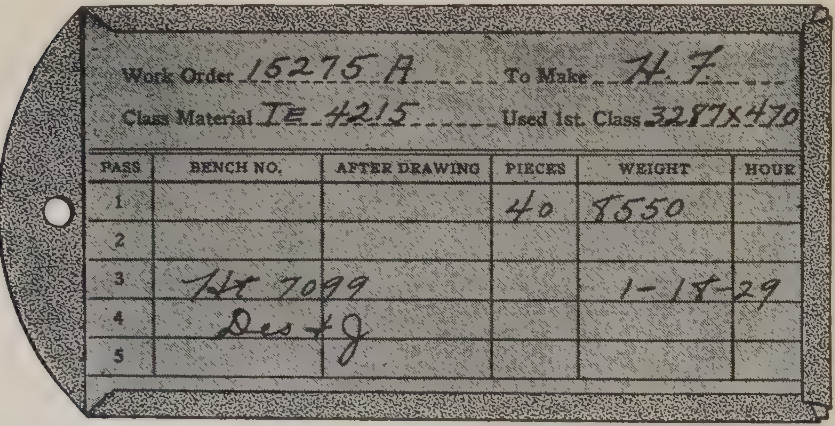
No. 39

Melting	1	Piercing Mill	
Blooming	2	Hot Finish Tubes	
Blooming Mill Tests		Pointing	
Pit Anneal Blooms	3	Pickling	12
Pickle Blooms	4	Cold Tube Inspection	
Chip or Grind Blooms	5	Annealing	
22" Mill Rolling	6	Cold Draw	
Hot Bed Anneal		Straightening	13
Pit Anneal 22" Mill		Cut Off Dept.	14
Inspection	7	Brightmanizing	16
Pickle Billets		Wire Pickling	
Chip or Grind Billets	8	Wire Drawing	
10" Mill Rolling	9	Forming	
Hot Bed Anneal		Tests for Inspection	15
Pit Anneal 10" Mill		Slug 100%	
Inspection	10		
Anneal for Cold Shearing			
Elec. Anneal Open	11		
Elec. Annealed Closed		Foreign Inspection	
Heat Treat		Final Inspection	17

FIGURE 69. *Route numbers, assigned according to a group of route cards—of which this is a sample—show what processes an order must go through*

this sheet is sent to the mill, and serves as a guide for subsequent operations.

The next step consists in entering the information concerning the order on a card, which is placed in a file, and in a book which serves as a combination check list and index for the file. Since this is the key to the whole system, it may merit a somewhat detailed description. The cards—shown in Figure 72—are of five different colors, red, blue, salmon, buff, and white. The colors indicate to some extent the route which that particular steel will follow after fabrication. For instance, red signifies hot-rolled stock that will probably receive no treatments except a final inspection; blue signifies stock that is subject to special routing; salmon indicates that the stock must be annealed for a cold shear and shear tested; buff, that it must be annealed and machine straightened; and white, that it will go to the tube mill. Of the last there will be more later. The upper line on these cards is filled in with the order number, the customer's name, the weight, or quantity of the order, the dimension of the finished stock, the analysis (usually designated by a symbol) and the shipping date. It will be noted that the lower column headings show the arbitrary routing for that particular stock, several headings being left blank for the insertion of special processes called for by the route card. As soon as the steel is poured, the heat number is entered in the extreme left-hand column. When the card is made out it is placed in the first panel of a visible file, shown in Figure 71.



Work Order 15275 A To Make H. F.

Class Material TE 4215 Used 1st. Class 3287X470

PASS	BENCH NO.	AFTER DRAWING	PIECES	WEIGHT	HOUR
1			40	8550	
2					
3	Ht 7099			1-18-29	
4	Des + J				
5					

FIGURE 70. *Each bundle of tubes from the cut-off saws is weighed and tagged with an identification card which supplies data for the tube mill file.*

This file has ten panels, each one representing a department, or process, through which the steel must pass. Only two are of particular note, the first is labeled "Not Rolled," and the third "Tube Mill." With regard to the first, since this system does not function until rolling operations are completed, no panels are provided for them. As to the latter, stock in the tube mill is controlled by a similar, but independent, system up to the point where it is ready for final inspection. It might be explained that some solid stock goes to the tube mill and is controlled by that system, because the brightmanizing, straightening, pickling and other processes which its route card calls for happen to be located in the tube mill. For instance, solid stock subject to route 39 would go through the tube mill, and would be entered on a white card. When the card is first made out, it automatically goes into the panel labeled "Not Rolled" where it remains until it is reported out of the last fabrication process, or into the tube mill.

Assuming that the stock moves in an orderly manner from one process to the next, the card representing that order moves with it from one panel to the next. Card movement is made on a basis of reports from the different departments concerning the movement of the stock. A single entry system is used in transcribing the information on the card. In other words the only record made is the amount of stock entering the department. The card is not moved until all the stock is reported into the next department. For instance, if some portion of an order in any given department should be sent back along the route for retreatment, while the rest was sent ahead, the amount sent back would be put on the card, and the card itself moved back. Its movement forward would then follow the delayed portion of the stock, rather than the movement of the other portion, until the two were reunited. The progress of the normal portion would be recorded simply by entries on the card. Thus it is possible from a cursory examination of the different panels to tell not only what the progress of an order is, but where any part of it is at any particular time, and why it is there. Also, if stock becomes mislaid in transit, which is perfectly possible when orders are split for any reason, it is possible to trace the missing portion to the department where it was last reported, and use that as a starting point for a search.

The system in the tube mill, although independent to some extent from the master system, works on the same principle. As the tubes come from the cutoff saws they are counted mechanically into bundles, averaging about 10,000 pounds each. Each bundle is weighed and tagged with a card similar to that shown in Figure 70. Each bundle of any particular order is designated by a letter added to the order number; in the case of the tag illustrated, the bundle is the first on order number 14130, or bundle number 14130A. As soon as the order is through the mill it is reported into the tube mill office, where the information is entered on a card somewhat similar to those used in the master file. In addition to the order number, the number of bundles is also reported, and entered in the same column as the order number, as 14130A, B, C and so on.

The system also differs in that the cards are not in a visible file and do not move with the material. Each card has a column corresponding to the different departments, and as the individual bundles move, their travel is recorded by entering them in the proper column, the entry being made by weight and number of pieces. The double entry form of recording is used; that is, the weight of a bundle is recorded on its entry to a department, and when it leaves

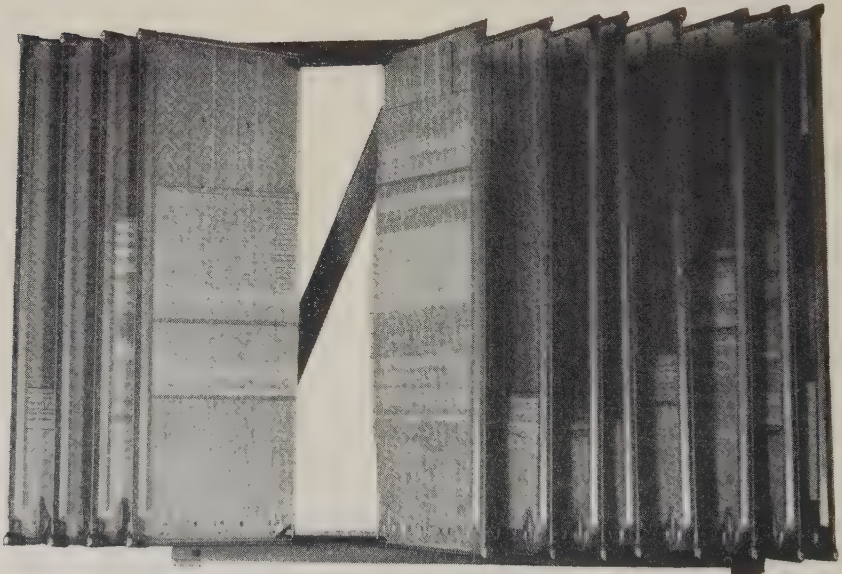
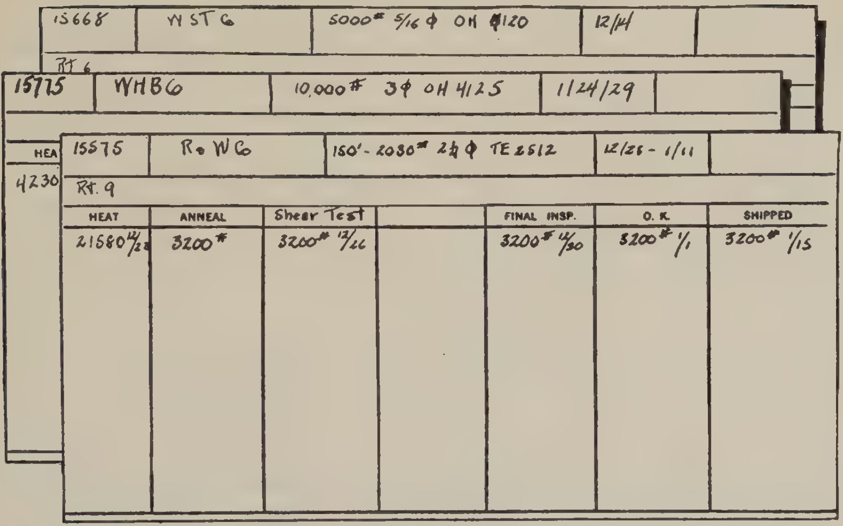


FIGURE 71. *The key to the whole system of production control is a visible card index with ten panels, each representing a department or process through which the steel must pass.*



15668 | WSTG | 5000# 5/16 ф OH 4120 | 12/14

Rt 6

15775 | WHBG | 10,000# 3ф OH 4125 | 1/24/29

HEA

4230

15575	R. WG	150'-2030# 2½ ф TE 2512		12/26-1/11		
Rt. 9						
HEAT	ANNEAL	Shear Test		FINAL INSP.	O. K.	SHIPPED
21580 12/23	3200#	3200# 12/26		3200# 12/30	3200# 1/1	3200# 1/15

FIGURE 72. *Control cards are moved from panel to panel as stock moves from one process to the next. Thus, one man has at his elbow a complete record of the status and location of every pound of steel in the mill*

its weight is again entered in the same column. This procedure is adopted for this particular class of stock because, during some of the processes—cutting-off, or cold-draw, or brightmanizing—the weight of a bundle decreases naturally, owing to the character of the process. But an unusual loss in weight signifies that something is wrong and gives a cue for prompt investigation as to the cause, which may be any one of a number of things. In fact this system has the same advantages of flexibility and simplicity for the tube mill production that the master system has for that of the mill as a whole.

When the stock has left the tube mill for final inspection preparatory to shipment the fact is reported to the main office, and the card representing that order is moved from the tube mill panel to the final inspection panel. The idea of having the tube mill production control operate independently in this manner has two particular advantages. In the first place it makes the main control system much less complex and bulky, and, secondly, it permits much closer control of conditions in the tube mill proper. At the same time, the control exercised by the master system is in no way weakened, and its reliability as a source of accurate and rapid information on the subject of plant production as a whole is in no way impaired. In fact, regarded as a whole the system is an interesting example of a simple solution to a decidedly intricate problem in production recording. From another viewpoint, it acts as a safeguard for the customer as well, because it prevents any mix-ups in orders and is of considerable assistance in expediting shipments.

MAKE PLANT RECORDS *LIVE* RECORDS

By C. H. WOLFE

Works Manager, Dalton Adding Machine Division, Remington Rand Business Service, Incorporated, Cincinnati

RAW materials and finished parts in the stock rooms of a manufacturing plant may not be in the shape of metal discs stamped with the government imprint and known as silver dollars, but they are none the less money in another form. And like cash, stores in a well managed plant require careful handling.

While the value is as large in one instance as the other, the complexity is even greater where valuable materials are concerned, for with money the denominations are relatively few and easily recognized, whereas with stock and parts the variety may be tremendous.

After all, a bank's transactions involving money and a manufacturing plant's handling of raw materials and finished parts are practically identical in principle. A depositor delivers money to his bank and is credited with the amount. Later he draws a check against a portion of this amount which reduces his balance to that extent.

Similarly, materials received by the manufacturer are credited to the stock account and the balance reduced as stock is withdrawn on properly presented requisitions. The bank's customer ledger sheet and the perpetual inventory sheet in the manufacturing plant, so far as their function and essential contents are concerned, are practically the same.

Since these two are practically identical in purpose and since they cover practically identical transactions, the thought came to me not long ago, why shouldn't bank customer accounts and factory stock accounts be handled by the same modern methods? In other words, why not use in keeping up the factory perpetual inventory the same bookkeeping machines used in banks with the same advantages in the way of time-saving and accuracy?

So in our own plant we have pursued this thought and are taking our own medicine. In other words, we who for years have been making bookkeeping machines for banks, are now adapting this equipment to our own needs.

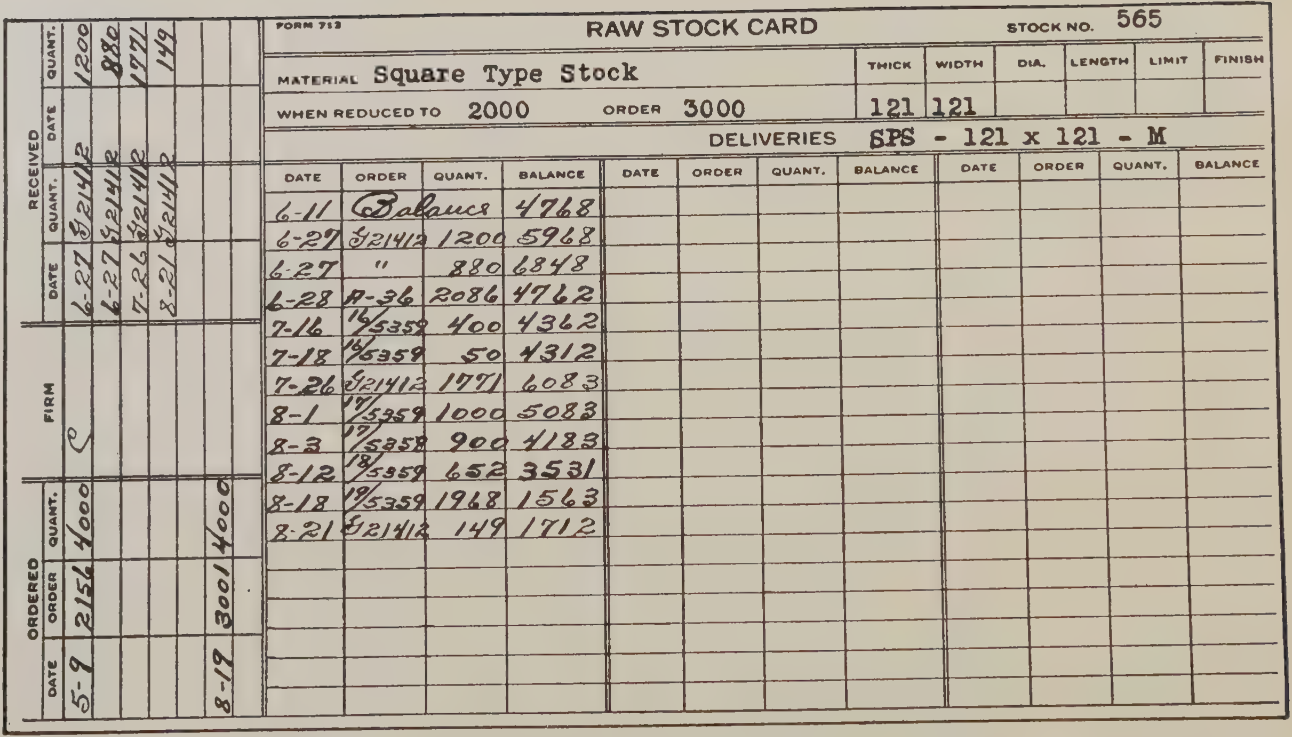
Let us see how this method works out in keeping a raw material inventory—although the procedure is practically identical where finished parts are concerned.

Formerly postings were made in longhand to the perpetual inventory card from the regular stock requisitions. Errors in addition and subtraction under this method were of course readily possible but beside this type of mistake, there are others that come from the very fact that the work is done in longhand. For instance, an extra flourish of the pen may carry the vertical part of the figure "7" down into the space below where later it may be interpreted as a "1" and thus throw out the balance by one, by ten, one hundred, or a thousand depending upon its position.

Or in a careless moment the clerk may add instead of subtract when there has been a withdrawal of stock. An example comes to mind where once this occurred and caused us considerable embarrassment. It gave us the impression that we had 60 pounds more of a special steel than we really owned. To rectify the error and cover our needs in sufficient time cost us some 10 dollars in telegrams and considerably more in express charges, to say nothing of the intangible losses due to delay.

Under the new method, using a bookkeeping machine, some of the errors cited above would be impossible and others extremely unlikely. The machine picks up the old balance, adds or subtracts the new figures and gives the total. Furthermore, the machine is equipped with a tally roll which serves to verify the postings just as it performs similar service in banks.

When the requisitions are received from the stores department by the girl doing the posting to the balance-sheet, she first totals the requisitions and thus secures a pre-determined total, doing this on an adding machine. This total is later checked against the tally roll after the requisitions have been posted, enabling her to make sure that she has posted all the requisitions and posted them for the proper amounts.



FORM 713

RAW STOCK CARD

STOCK NO. 565

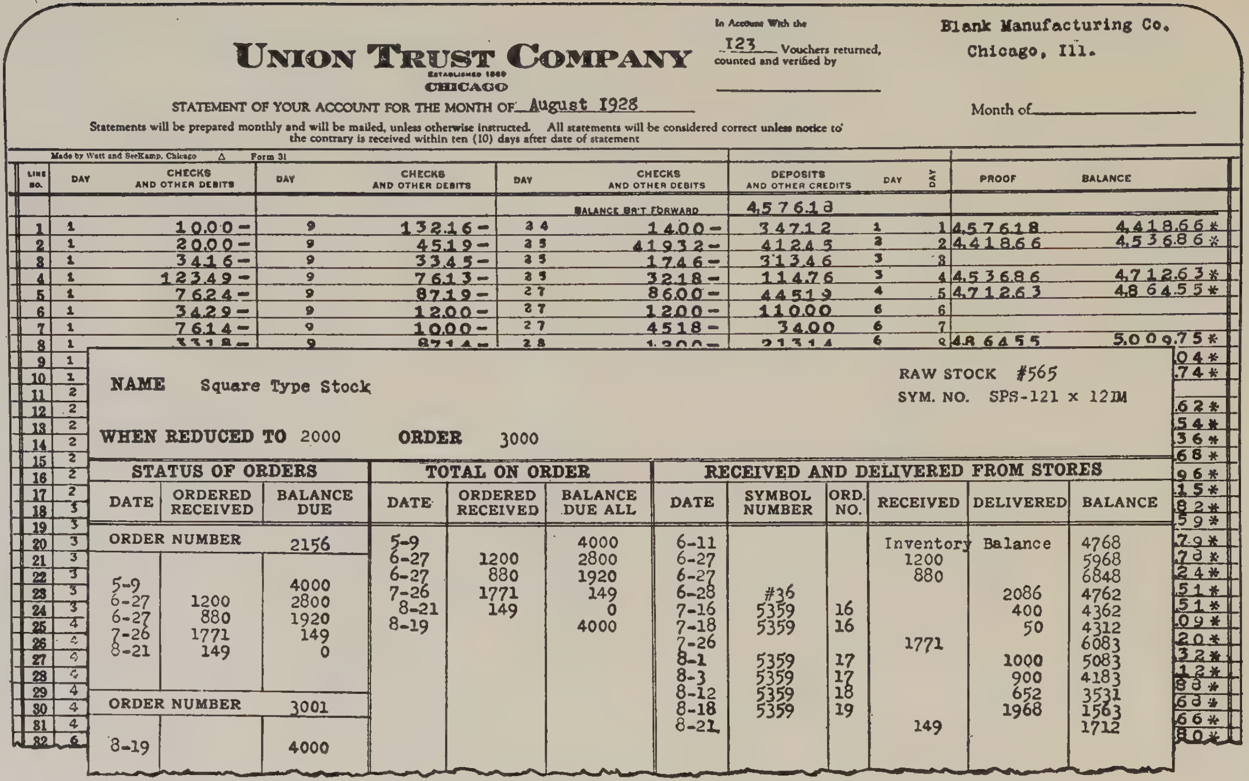
	THICK	WIDTH	DIA.	LENGTH	LIMIT	FINISH
MATERIAL Square Type Stock						
WHEN REDUCED TO 2000 ORDER 3000	121	121				

DELIVERIES SPS - 121 x 121 - M

DATE	ORDER	QUANT.	BALANCE	DATE	ORDER	QUANT.	BALANCE	DATE	ORDER	QUANT.	BALANCE
6-11	Balance		4768								
6-27	G21412	1200	5968								
6-27	"	880	6848								
6-28	A-36	2086	4762								
7-16	16/5359	400	4362								
7-18	16/5359	50	4312								
7-26	G21412	1771	6083								
8-1	17/5359	1000	5083								
8-3	17/5358	900	4183								
8-12	18/5359	652	3531								
8-18	19/5359	1968	1563								
8-21	G21412	149	1712								

ORDERED			FIRM	RECEIVED			
DATE	ORDER	QUANT.		DATE	QUANT.	DATE	QUANT.
5-9	2156	4000	C	6-27	G21412		1200
				6-27	G21412		880
				7-26	G21412		1771
				8-21	G21412		149
8-19	3001	4000					

FIGURE 73. *When postings to perpetual inventory cards were made in longhand, it was entirely possible for the clerk to add instead of subtract when there had been a withdrawal of stock*



UNION TRUST COMPANY
ESTABLISHED 1860
CHICAGO

In Account With the
Blank Manufacturing Co.
Chicago, Ill.

123 Vouchers returned, counted and verified by

STATEMENT OF YOUR ACCOUNT FOR THE MONTH OF August 1928

Month of

Statements will be prepared monthly and will be mailed, unless otherwise instructed. All statements will be considered correct unless notice to the contrary is received within ten (10) days after date of statement

Made by Watt and SeeKamp, Chicago △ Form 31

LINE NO.	DAY	CHECKS AND OTHER DEBITS	DAY	CHECKS AND OTHER DEBITS	DAY	CHECKS AND OTHER DEBITS	DEPOSITS AND OTHER CREDITS	DAY	DAY	PROOF	BALANCE
						BALANCE BR'T FORWARD	4,576.18				
1	1	10.00–	9	132.16–	24	14.00–	347.12	1	1	4,576.18	4,418.66*
2	1	20.00–	9	45.19–	25	419.32–	412.45	2	2	4,418.66	4,536.86*
3	1	34.16–	9	33.45–	25	17.46–	313.46	3	3		
4	1	123.49–	9	76.13–	25	32.18–	114.76	3	4	4,536.86	4,712.63*
5	1	76.24–	9	87.19–	27	86.00–	445.19	4	5	4,712.63	4,864.55*
6	1	34.29–	9	12.00–	27	12.00–	110.00	6	6		
7	1	76.14–	9	10.00–	27	45.18–	34.00	6	7		
8	1	33.18–	9	87.14–	28	[illegible]	213.14	6	[illegible]	4,864.55	5,009.75*
9	1										04*
10	1										.74*
11	2										
12	2										.62*
13	2										54*
14	2										36*
15	2										68*
16	2										96*
17	2										15*
18	3										82*
19	3										59*
20	3										79*
21	3										78*
22	3										24*
23	3										51*
24	3										51*
25	4										09*
26	4										20*
27	4										32*
28	4										12*
29	4										88*
30	4										68*
31	4										66*
32	6										80*

NAME Square Type Stock

RAW STOCK #565
SYM. NO. SPS-121 x 12DM

WHEN REDUCED TO 2000 **ORDER** 3000

STATUS OF ORDERS

DATE	ORDERED RECEIVED	BALANCE DUE
ORDER NUMBER		2156
5-9		4000
6-27	1200	2800
6-27	880	1920
7-26	1771	149
8-21	149	0
ORDER NUMBER		3001
8-19		4000

TOTAL ON ORDER

DATE	ORDERED RECEIVED	BALANCE DUE ALL
5-9		4000
6-27	1200	2800
6-27	880	1920
7-26	1771	149
8-21	149	0
8-19		4000

RECEIVED AND DELIVERED FROM STORES

DATE	SYMBOL NUMBER	ORD. NO.	RECEIVED	DELIVERED	BALANCE
6-11			Inventory	Balance	4768
6-27			1200		5968
6-27			880		6848
6-28	#36			2086	4762
7-16	5359	16		400	4362
7-18	5359	16		50	4312
7-26			1771		6083
8-1	5359	17		1000	5083
8-3	5359	17		900	4183
8-12	5359	18		652	3531
8-18	5359	19		1968	1563
8-21			149		1712

FIGURE 74. *With the bookkeeping machine, postings may be made to the perpetual inventory card with the same accuracy that the banker gets in keeping track of his customer's account*

It will be noticed from a perusal of the two forms illustrated how the same entries appear under the old and the new method.

We have some 15,000 finished parts to handle, which is no mean job. Furthermore the parts are very active. There is almost continuous turnover. This rapidity of movement of the parts increases the difficulty of control.

While our materials and parts are sometimes extremely small, as such things go, the principles involved hold in practically all manufacturing plants. The same procedure of checking valuable materials into storage, carefully accounting for them at all times and releasing them only on requisition is common to all well managed plants. The degree of complexity varies only with the type of product manufactured.

As to savings, it formerly required two girls in the posting work on the raw material inventory and four on the finished parts. The bookkeeping machine cuts the work in half. That is, it does the work with three girls instead of six, and maintains a high degree of accuracy.

And the machine allows prompter work. Production records that come to light days after the transaction itself is performed are not living records at all but rather bits of dead history. With the machine method a perpetual inventory record is possible that reflects conditions almost immediately. It is just as possible and as feasible for a manufacturing plant to know where everything is in its perpetual inventory every morning as it is with a bank that strikes its balance every night.

We put great stress on accuracy. This has led us through a changing course in the matter of stock control procedure, but with this new method we think we are nearing the end of the road.

Several years ago we went so far as to adopt the perpetual inventory plan. We applied to it almost a daily spot check on a number of items and this revealed such a variance from the true figure that we gave up the method. Then some three years ago we started it up again with a closer attention to accuracy. This time the same sort of spot check showed that the plan was working well. The errors discovered then seemed to be confined chiefly to those of a clerical nature, but now with the bank type of bookkeeping machine in use, we think we have the problem almost completely "licked."

200% INCREASE IN PRODUCTIVE EFFICIENCY

By W. H. GESELL

Vice-President and General Manager, Lehn and Fink, Inc.

IT IS a comparatively easy matter to plan for the efficient production in large amounts of a few items. Raw and packing materials can be contracted for in advance and delivery dates given; systems of handling and working methods can be readily simplified; cost finding and accurate record keeping are facilitated. In general, it is easy to apply an efficient straight line production scheme where large runs of a few items are concerned.

But where one is confronted with the proposition of efficiently planning for the production of several hundred items, needed in varying amounts, the problem is not so easy to solve. When a limited number of employees have to do all these operations, many labor hours may be lost unnecessarily in changing the work place and in making ready for the various runs. Also, a rather high inventory of raw materials must be kept on hand in order to guard against delays in production.

Several years back our organization took over the production of an established line of cosmetics. It is the purpose of this paper to describe the methods used in putting on an efficient planning basis the production of the several hundred different items connected with this line.

The production of a high class line of cosmetics varies a great deal from the production of usual merchandise. Special care must be exercised so that the finished product will be representative of the line. The labels, ribbons, stickers, cellophane wrappings and other decorative frills must be exactly right. To do all this and yet economically produce in satisfactory quantities, was the proposition with which we were faced.

An examination of the existing conditions of the new line showed that the manufacturing and packing of the various items was determined by the immediate needs of the finished-stock room. As soon as the stock of an item was low, the manufacturing had to start. The lack of a definite production schedule resulted in short, uneconomic manufacturing runs. Provisions for raw and packing materials were more or less a hit or miss matter and presented a very difficult task to our purchasing department. Naturally, under such a poor system back orders were quite frequent.

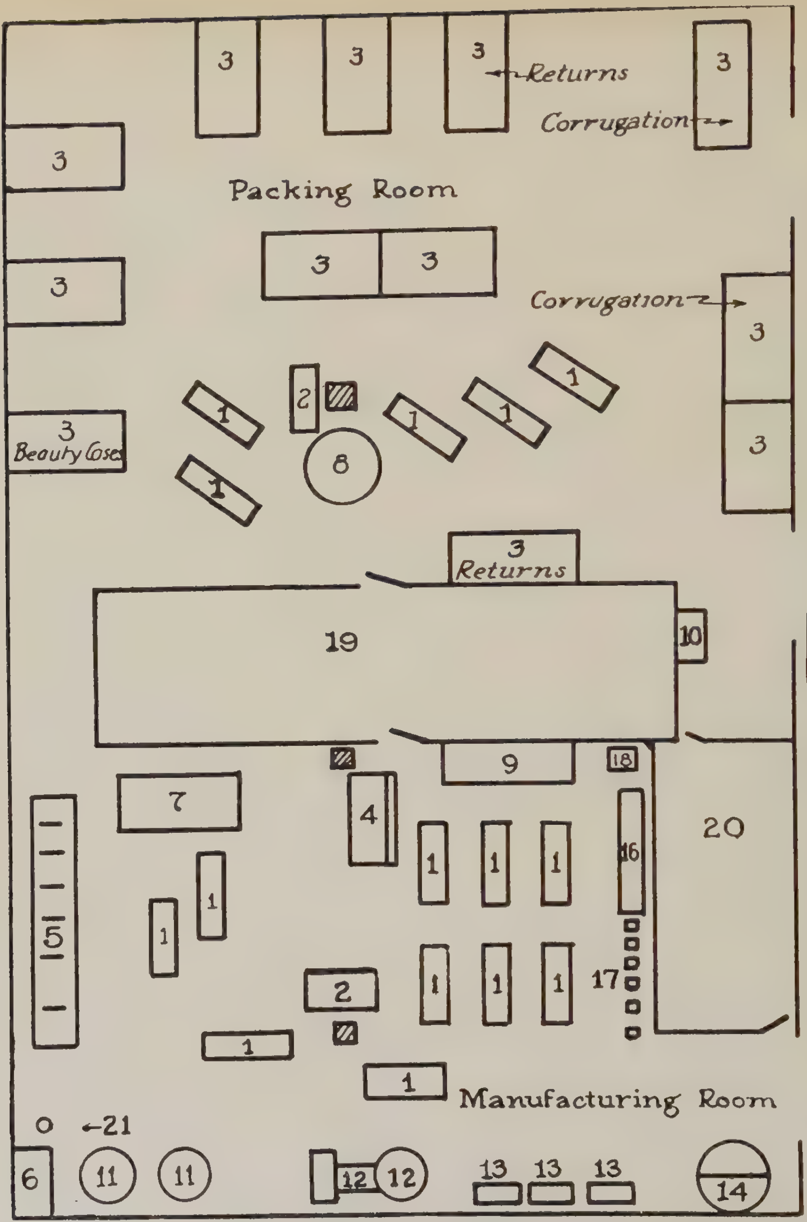
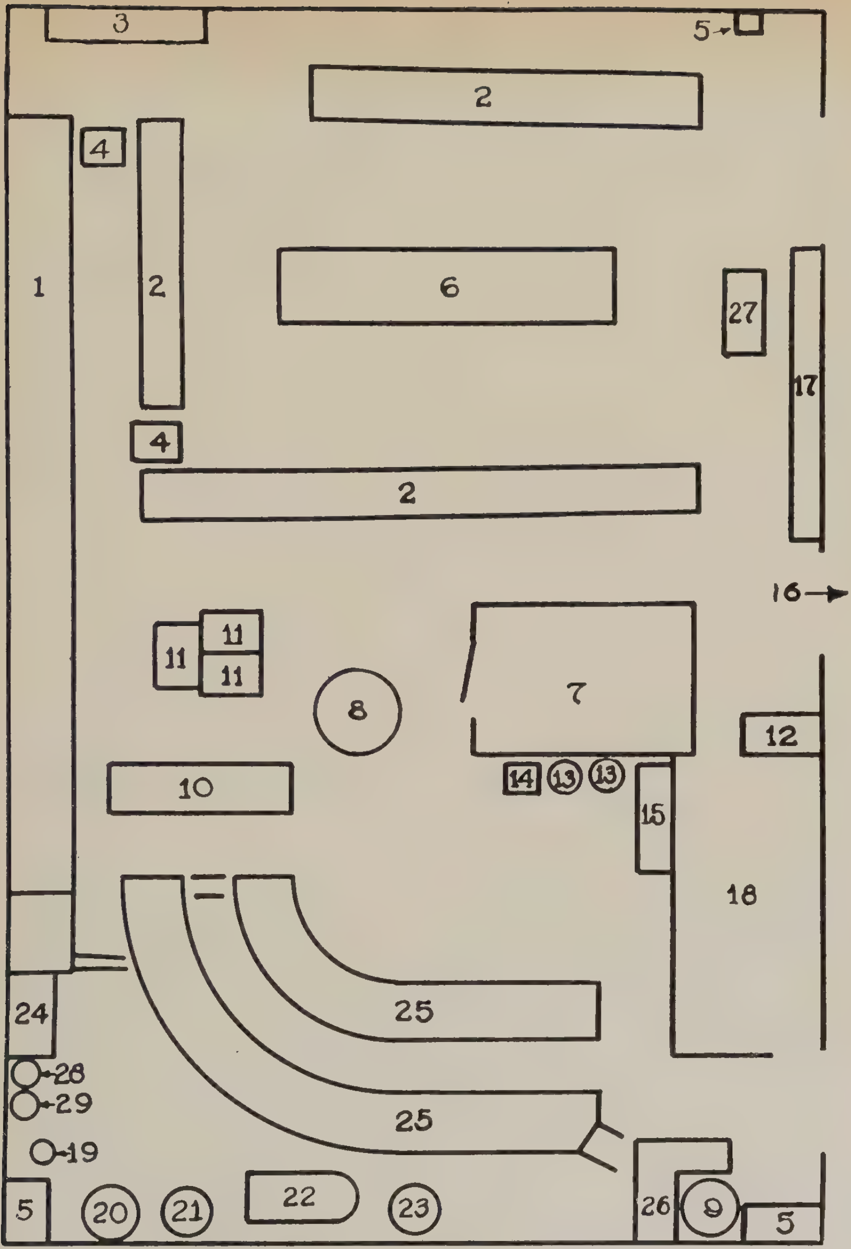

3
3
3
Returns
3
Corrugation
3
Packing Room
3
3
3
Corrugation
3
1
2
1
1
3
Beauty Case
3
1
8
1
3
3
Returns
19
10
1
1
9
18
7
4
20
16
1
1
1
1
5
1
1
1
1
1
1
2
1
17
1
1
Manufacturing Room
o
←21
6
11
11
12
12
13
13
13
14

FIGURE 75. *The previous arrangement of equipment was not planned to provide for rapid straight line flow of work and minimum handling*

1. Manufacturing work tables
2. Desk (foremen)
3. Packing work tables
4. Experiment table
5. Crates
6. Sink
7. Returns table
8. Fountain
9. Prescription table
10. Movable shelf rack
11. Cream bottles
12. Mixer
13. Gas stoves
14. Bottle washer
15. Cotton filler
16. Bottle rack
17. Filter rack
18. Russian pos't lotion
19. Stock room
20. Powder room
21. 5-gal. bottle washer


3
5
2
4
1
2
6
27
17
4
2
16
11
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14
13
13
15
18
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22
23
26
9
5

FIGURE 76. *The new layout has cut costs by applying mass production principles and handling methods to the diverse lines of product*

1. Double runway
2. Belt coveyor table
3. Machine part storage
4. Labeling machine
5. Sinks
6. Work tables
7. Stock room
8. Wash basin
9. Bottle washer
10. Returns table
11. Desks
12. Tissue storage
13. Kiefer filter
14. Pump
15. Prescriptions
16. Hall
17. Shelves
18. Powder room
19. Bottle washer
20. Cream kettle
21. Cream kettle
22. Mixer
23. Steam kettle
24. Muscle oil storage
25. Runway
26. Table
27. Table for corrug.
28. Cotton filler
29. Mill

In working out the system of planned production it was decided to put the production on a basis of a two-month manufacturing cycle, that is, to manufacture each item in a quantity sufficient to last about two months. To carry this plan through, a survey was first made of the finished stocks and of the amounts needed for a two months' supply. The time necessary for the manufacturing and packing of each item was then calculated.

All pending requisitions were used as a basis for the first month's work. The sequence of manufacture of these items was determined by the supply on hand at that time.

In order to have the necessary raw and packing materials on hand, follow-up sheets were made out, Figure 77.

During the following two months the finished stock of items was brought up to the desired amounts and a system for planned production was put into effect.

An outline of the planning system which we finally developed is as follows:

At the beginning of each month the production schedule for the following two months is made out to meet the requirements of the calculated sales for a two-month period. These calculated sales figures are based on the average monthly sales for the preceding year plus a percentage increase due to additional business, and are figured out by the planning department.

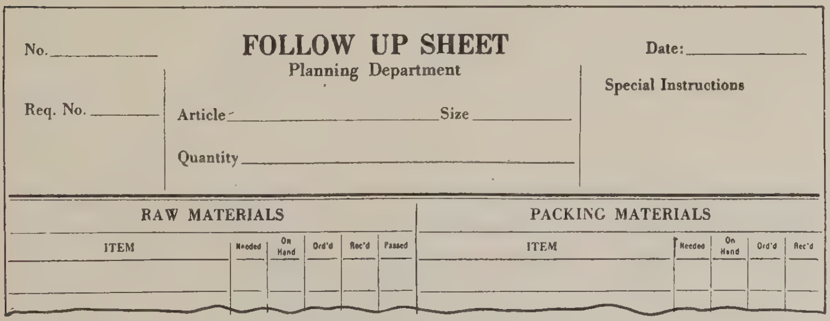
The production is planned so that each item is made only once every two months and that a minimum of a three weeks' supply of finished goods is always on hand. With these facts in mind, the production schedule is made out on the first of each month.

Items which are low in stock are reported daily to the factory manager, planning department and manufacturing head, and those lowest in stock are manufactured first. This report is made out by the finished-stock room foreman, who gets this information from his perpetual inventory showing the quantity of each item on hand. The minimum amount, a three-weeks' supply, is printed on the stock card, and as soon as the supply on hand falls down to this amount, the item is reported as low in stock. This gives the planning department an accurate figure with which to check their schedule, and allows enough time for the production department to make all arrangements for its manufacture.

The follow-up sheets are made out by the planning department, which must see that all the raw materials for both manufacturing and packing for a two-months' supply of each item are on hand when they are needed. A minimum emergency stock of raw materials covering a three-week period is always kept in excess of the two-month supply. This minimum amount is entered on the stock card of the perpetual inventory, and as soon as the supply on hand falls down to this amount the stock clerk has to send an order through for the amount, also given on the stock cards. Of course, old stock is always used up first. Materials are so ordered that they will arrive about ten days before they are needed for manufacturing. Thus the amount of capital tied up in raw material is reduced to a minimum.

The planning department writes out a production order sheet, Figure 78, for each item to be manufactured according to schedule. This gives the manufacturing department complete information as to size and quantities of the item to be manufactured. On the back is the time record. The material used and time spent and the amounts of items produced are entered on the production sheets by the time clerk. This sheet gives complete cost information. It also must check up with daily production and time records. A further check is obtained by comparing the quantities of finished items sent from the manufacturing department to the finished goods department, with the amounts shown on the daily production and time records.

An investigation of the method of handling materials, taking into consideration the elimination of waste motions and unnecessary effort, indicated that a rearrangement and replacement of equipment was necessary. This was done step by step in order not to inter-



No.________

FOLLOW UP SHEET

Planning Department

Date:________

Special Instructions

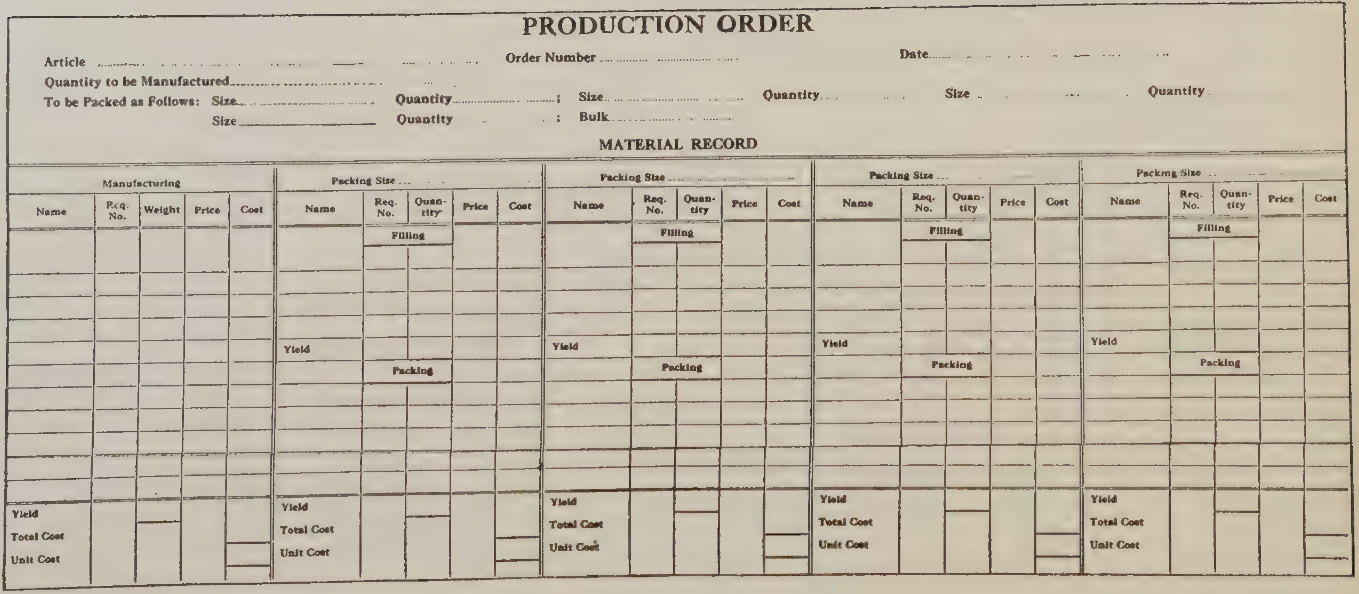
Req. No.________

Article________ Size________

Quantity________

RAW MATERIALS						PACKING MATERIALS				
ITEM	Needed	On Hand	Ord'd	Rec'd	Passed	ITEM	Needed	On Hand	Ord'd	Rec'd

FIGURE 77. *Stocks of raw and packing materials are checked well in advance of manufacturing*



PRODUCTION ORDER

Article .... Order Number .... Date ....

Quantity to be Manufactured ....

To be Packed as Follows: Size .... Quantity ....; Size .... Quantity .... Size .... Quantity ....

Size .... Quantity ....; Bulk ....

MATERIAL RECORD

Manufacturing					Packing Size ...					Packing Size ...					Packing Size ...					Packing Size ...				
Name	Req. No.	Weight	Price	Cost	Name	Req. No.	Quantity	Price	Cost	Name	Req. No.	Quantity	Price	Cost	Name	Req. No.	Quantity	Price	Cost	Name	Req. No.	Quantity	Price	Cost
						Filling					Filling					Filling					Filling			
					Yield					Yield					Yield					Yield				
						Packing					Packing					Packing					Packing			
Yield					Yield					Yield					Yield					Yield				
Total Cost					Total Cost					Total Cost					Total Cost					Total Cost				
Unit Cost					Unit Cost					Unit Cost					Unit Cost					Unit Cost				

FIGURE 78. *A production order authorizes manufacturing to begin. The time record is entered on the opposite side*

fere with the production. Special care was taken to have the equipment of proper height to eliminate unnecessary fatigue, and also to arrange the work place in such a fashion that motions were reduced to a minimum. A steady flow of work was obtained by dividing each job into simple successive operations, each operator taking care of one operation at a time with the material being delivered to the worker.

It is of interest to touch briefly on the subject of selecting workers for the kind of job to which they are naturally most suited. This is nothing new, and our experience is just another bit of evidence of how valuable a study of the natural aptitudes of the workers may be. We first measured the output of the workers and compared this with a standard output. If a worker persistently failed to produce satisfactorily at one kind of work she was transferred to another on which we thought she might be better suited. Since the work of this department varies, we were able to place every worker at the job which she could perform best.

In closing, it might be of interest to note that by the above improved methods, without increasing the amount of help and floor space, we were able to increase the productive efficiency of this department by approximately 200 per cent.

HANDLING EQUIPMENT HAS GIVEN US CONTINUOUS UNIFIED PRODUCTION

By GEORGE BELKNAP

Vice-President, Belknap Manufacturing Company, Bridgeport, Connecticut

AN individual plant may be laid out so that the progress of material through it is comparable either to the criss-crossing of a game of checkers or to running on a race track. You can run around the right kind of a curve without material reduction in speed but if you have to turn a 90 degree corner you are bound to slow down.

The best way to illustrate this idea is to show what we have developed in our works since we moved into a new plant five years ago. We are valve manufacturers and the various parts, practically all brass or nonferrous alloys, are cast, machined and assembled in three separate departments, necessitating considerable movement of materials.

The general strategy, of course, is to have these materials progress from the raw materials stores to finished stores with the least possible resistance. This is accomplished partly by careful plant layout, partly by unstinted use of mechanical handling and automatic machinery and by the application of those standard practices for the avoidance of unnecessary lifting and handling which are not new in principle but are always of interest.

Starting at the beginning, then, the raw materials stores are located at one end of the ground floor of the two-story building. They consist mainly of metals in ingot form, which we find cheaper than scrap metal because there is less handling cost. As the ingots are received they are piled directly on lift-truck platforms and after weighing are taken to the stock bins.

The first manufacturing operation is that of melting. The melting department is on the second floor. The various charges are assembled and weighed from the bins in the raw materials stores, placed in pans and set on the conveyor which carries them upstairs to the melting room. This is all done by one man.

The conveyor consists of a short roller section and a booster of the chain belt type which raises the tote boxes to within three feet of the ceiling. The boxes then travel on a section of gravity conveyor to a second booster by which they are raised to a level about two feet above the melting room floor and they continue at this level on a second roller section, whence they are removed as needed. Empty boxes are returned to the raw materials stores on a gravity conveyor.

Sand, coal, coke, and the like, are taken to the molding room, also on the second floor, the first thing in the morning in wheelbarrows on the freight elevator. This is the only instance in which the elevator is used for moving materials. The bins for these molders' supplies are adjacent to the elevator downstairs, and upstairs the elevator entrance is close to the molding room. This line of travel does not cross any other line.

Cores are made in core machines with multiple core boxes in gas-fired ovens to reduce labor and supervision. This department operates independently of the others, as we plan to have between 300,000 and 400,000 cores on hand, to be able to fill orders for standard stock without delay.

Briefly, the operations in the casting department consist of molding, melting and pouring, dumping the molds, knocking out the cores, cutting off sprues, cutting off the gates from the castings and sand-blasting. Then come the hydraulic test, the acid dip for parts to be plated, inspection and delivery to rough stores.

In the melting room we use electrical arc furnaces arranged in aisles, with overhead trolleys along each aisle extending to the pouring aisles for the transportation of the molten metal. In the molding room we have a conveyor in back of each molder on which the completed mold is taken by helpers to the pouring aisles. The helpers then transfer the poured molds to the molders run to the dumping position, after which the castings are taken to the knock-out room where the cores are removed by air. Burned core sand is shoveled into a chute leading to the yard. The gates with the castings are sent through another chute to a bench on the first floor around which the cutting-off machines are grouped for cutting off sprues and the gates from the castings. At the last step the castings slide through a chute into a tote pan which, when full, is placed in the sand blast. During the inspection which follows, the pans are placed on a platform which is finally carried to rough stores by means of a lift truck. Then the parts are counted and weighed and each pan is tagged with the quantity in it and the drawing number.

So it will be seen that by using conveyors, trolleys, chutes and lift trucks we have created a continuous, unified chain in which the principle of avoiding all unnecessary carrying, lifting and handling has been applied throughout.

From rough stores the pans are taken upstairs to the machine shop on a conveyor line consisting of a roller section about 35 feet long, a push-bar type booster section about 45 feet long and a final roller section about 30 feet on the machine floor at bench height. As the pans are taken off they are set on platforms for delivery by lift truck to the proper machines.

Automatic machines perform 75 per cent of the work. There are four rows of them, each for a different class of work which starts near the conveyor and progresses toward the finished inspection department. Finished inspection is done on benches in front of the windows, after which the parts are passed in boxes downstairs to finished stores on a gravity conveyor.

To accomplish its purpose this conveyor is made up of several sections. First there is a short roller section on the machine-shop floor, then a metal chute about 8 feet long through the floor. A gravity roller section, about 80 feet long, delivers to a spiral roller which lowers the boxes 5 feet to a final roller section, extending into the storeroom.

The strategic use of conveyors and lift-truck platforms centers conspicuously around this storeroom and the finished-assembly department. There is one conveyor to carry parts to the polishing room and another for their return. Fast moving stock, whether it comes from the inspection department or polishing, is placed on platforms.

When a run has been accumulated, the parts which are to be plated are taken on platforms to the buffing room, thence on platforms to the automatic plating tanks and back to finished stores on a gravity conveyor, where sufficient parts are accumulated to make up a complete assembly. Eighty per cent of our material is handled all the way through the main assembly room on conveyors which run along the back of the benches.

Finally, every valve is tested according to the use for which it is intended and then goes to the shipping room on a conveyor 186 feet long which delivers at bench height. The avoidance of handling and lifting in this department makes it possible to employ girls to do the wrapping. A booster is used to carry two-wheeled hand trucks from the shipping-room floor to the shipping platform.

It will be seen that we have consistently used every practicable labor-saving device including conveyors, lift trucks, automatic machinery and other devices known to scientific management, in order to reduce fatigue, economize on labor costs and eliminate human uncertainties to the greatest possible extent. The conveyors alone return something like 80 per cent annually on the investment. Furthermore, as a result of the care given originally to our layout, it has been possible to add the equipment necessary for our doubled production without changing the location of any machinery originally installed. And we do not feel that we have yet reached the limit of possible returns.

Authorities on time and motion study have found that the fatigue element increases sharply in work where the handling time predominates. With mechanization of the bulk of this handling we not only reduce the number of employes but relieve those that are required, of the bulk of the fatigue element, with a corresponding increase in alertness.

HANDLING IS PART OF PRODUCTION

By GORDON LEFEBVRE

Vice-President in Charge of Production, Oakland Motor Car Company, Pontiac, Michigan

WEBSTER'S definition of efficiency gives it as "the ratio of work got out . . . to the energy put in"—a combination of words which bears forcibly on the production problems of industry. The employment of time-study experts, a planning department, and the constant development of specialized production tools, are all parts of the aim to increase that "ratio of useful work," which is fundamental and vital in management. And the task of every production executive becomes a six-day contest with the inertia of existing conditions in which alert brain power wins.

In the Oakland plant this fact is recognized, and our manufacturing program is, we believe, the result of straight-line thinking as well as straight-line production.

The plant site and building layout is the starting point for our working out Webster's definition. As we build the Pontiac and Oakland cars at the one site, a consideration of this factor will apply to both plants. The point is that we have the needed area and can eliminate overcrowding. Oakland motors are manufactured at our plant No. 5 in Pontiac, one and one-half miles from the main assembly plant, and for the purposes of this article that plant will be considered as a feeder unit. Fisher plant No. 18, in Detroit, where Oakland closed bodies are made, as well as the various other plants which provide our semi-finished material such as frames, axles and so on, must also be considered feeder units to the main plant.

The main plant in which Oakland cars are assembled and from which they are shipped is adjacent to and joined up with the Pontiac plant. It covers 80 acres of floor space. Its location means, first, low fixed-property charges for land. Plans were therefore drawn without too great an influence from the consideration of per square foot land cost, often a baleful one. Second, the fact that the two cars are produced virtually under one roof, though with separate personnel, makes possible certain common, therefore economical, operations.

With available space limited only by our desire to use it well, our layout shows some distinctive detail. Glancing at a blueprint of

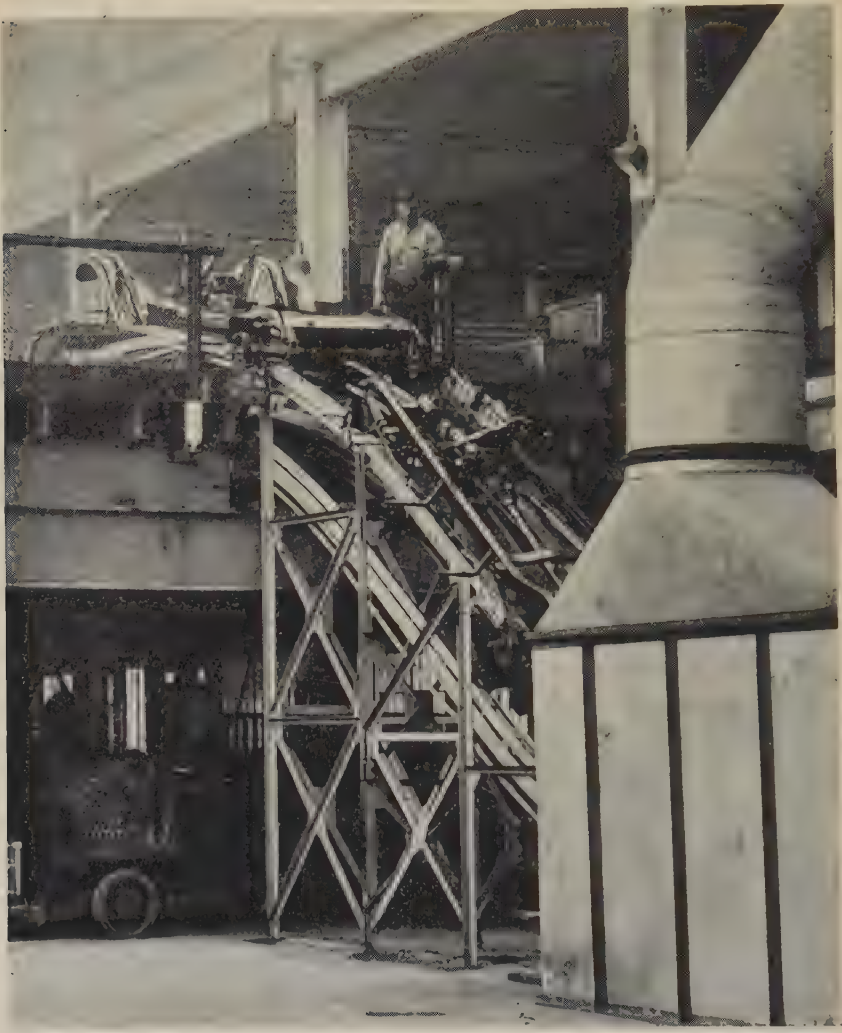


FIGURE 79. *After enameling fenders, running and splash boards, conveyor goes up the hump and runs at second-floor level. This is the ninth operation*

the Oakland-Pontiac plant one might think it to be the layout for a railroad freight terminal. And in a sense it is just that—for the in- and out-handling of raw, semi-finished and finished material in any plant comprises a problem the equal of any other which passes across the executive's desk. We think we have as nearly approached the solution of this problem in plant operation as anyone could.

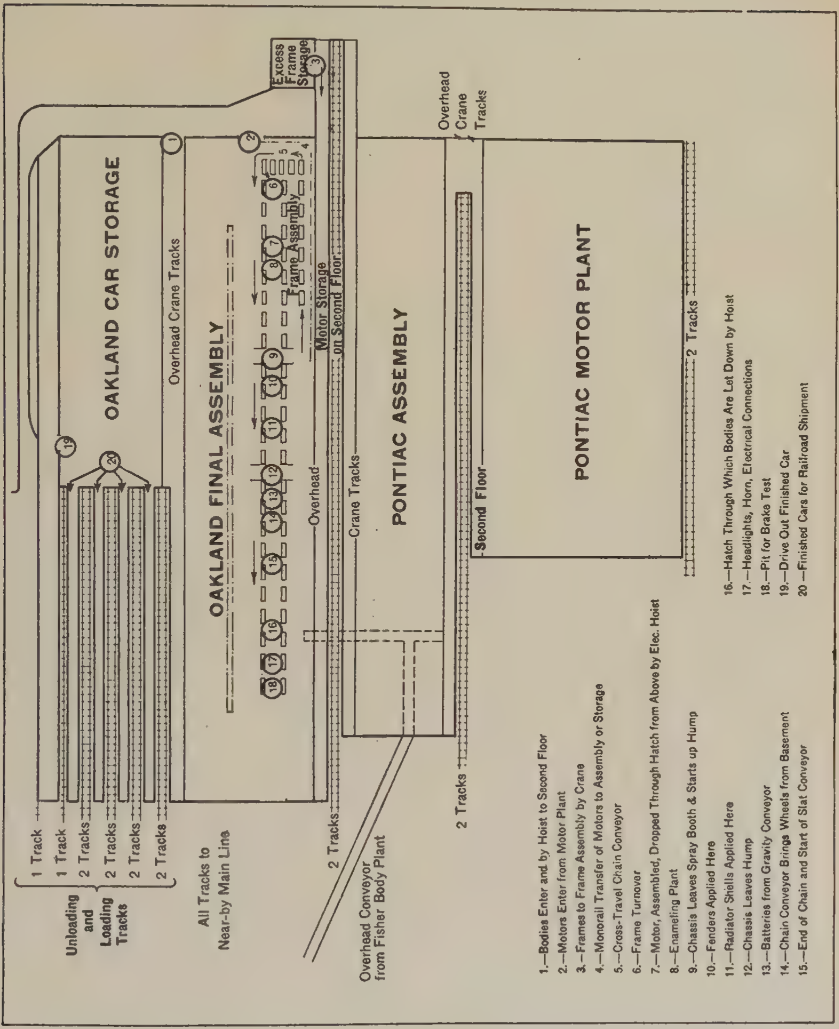

OAKLAND CAR STORAGE
OAKLAND FINAL ASSEMBLY
PONTIAC ASSEMBLY
PONTIAC MOTOR PLANT
Excess Frame Storage
Overhead Crane Tracks
Frame Assembly
Motor Storage on Second Floor
Overhead
Crane Tracks
Overhead Crane Tracks
Second Floor
2 Tracks
1 Track
1 Track
2 Tracks
2 Tracks
2 Tracks
2 Tracks
Unloading and Loading Tracks
All Tracks to Near-by Main Line
2 Tracks
Overhead Conveyor from Fisher Body Plant
2 Tracks
1.—Bodies Enter and by Hoist to Second Floor
2.—Motors Enter from Motor Plant
3.—Frames to Frame Assembly by Crane
4.—Monorail Transfer of Motors to Assembly or Storage
5.—Cross-Travel Chain Conveyor
6.—Frame Turnover
7.—Motor, Assembled, Dropped Through Hatch from Above by Elec. Hoist
8.—Enameling Plant
9.—Chassis Leaves Spray Booth & Starts up Hump
10.—Fenders Applied Here
11.—Radiator Shells Applied Here
12.—Chassis Leaves Hump
13.—Batteries from Gravity Conveyor
14.—Chain Conveyor Brings Wheels from Basement
15.—End of Chain and Start of Slat Conveyor
16.—Hatch Through Which Bodies Are Let Down by Hoist
17.—Headlights, Horn, Electrical Connections
18.—Pit for Brake Test
19.—Drive Out Finished Car
20.—Finished Cars for Railroad Shipment

FIGURE 80. *Building layout of the main plant in which Oakland cars are assembled. Principal steps in the assembly are indicated by the circles, and an explanation of these steps is given in the legend*

And we do not have a simple problem. In the assembly of an automobile the material used is diverse—heavy parts of concentrated weight such as complete motor assemblies and storage batteries; bulky and heavy parts such as chassis frames; and light bulky materials such as semi-finished body interior parts. We manufacture Oakland open bodies in this plant. There is also the handling of closed finished bodies which must be transferred to our assembly line without mar or scratch. Handling is further complicated by the fact that some material is received in railroad shipments and some by truck.

A brief study of our layout will show the operating method we have evolved. On it is built the structure of the whole production flow.

From the main spur of the railroad just inside the west line of the Pontiac-Oakland property are six branch spurs curving by easy radius into the various plan buildings.

Parenthetically it will be noted that, with the exception of one which serves the loading dock to the north, all tracks are under roof. This means elimination of spoilage or damage due to adverse weather conditions, less intermediate haulage, and comfortable working conditions for the crews assigned to the job of loading and unloading. These spurs each split off into two or more upon their entrance into the buildings so that for service there are actually available 15 tracks.

As the plant covers three principal and distinct production operations—(a) the building of Pontiac motors, (b) the assembly of Pontiac automobiles, (c) the assembly of Oakland automobiles—tracks are laid to define the boundaries of each unit. In the two buildings where assembly is carried on, as cross-flow is required at each step along the main progressive line, the trackage is on both sides of the line. Here are the headwaters of the sub-assembly stream. All tracks are depressed to box-car platform level. And spanning the interior unloading bays for the length of the building are overhead craneways above the tracks, each provided with traveling cab-cranes of 10-ton capacity, which pick up material from lift trucks and spot it before doors to stock- or process-room; or handle it direct from gondola cars.

The result of this arrangement of car unloading is either a short intermediate haul or none at all, as the material may not be handled into stock but goes direct into process. Where this can be accomplished we invariably do it. One handling less, multiplied many times throughout a year's program, may reach a mountain peak in total savings. An important corollary of this in-handling is the provision of proper fixtures or skids designed not only to safeguard transport, but to make them easily handled when they reach the

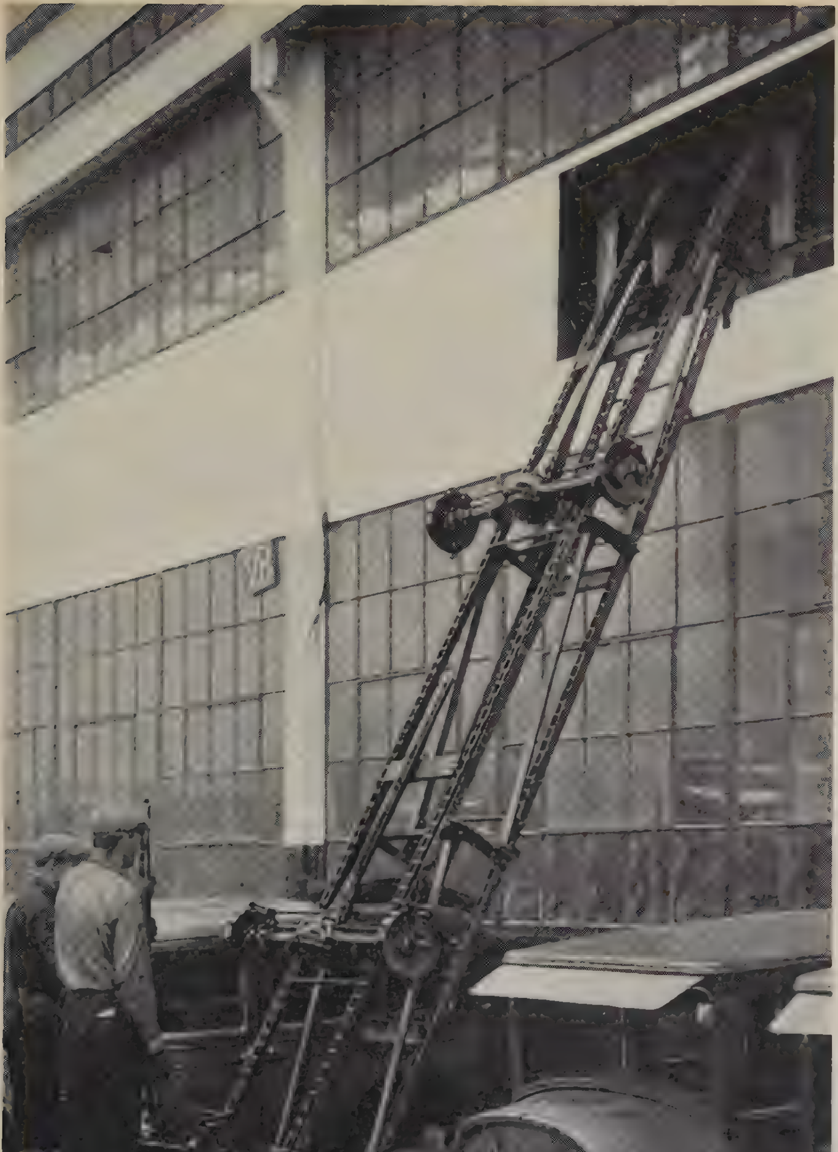


FIGURE 81. *Rear-axle assembly on chain conveyor. Where each operation is a matter of physical co-ordination, the continuous power conveyor is generally indicated*

workman at the first operation where the material in them is to be used.

For the stock which comes to us by motor transport—with the exception of special items such as the complete motor and the closed body—the lift truck used with floor boxes or special fixtures best fits the handling problem. The type of truck to use, whether electric-battery type or gasoline-electric, is still an open question. We have both and each has distinct advantages. Our buildings are of the two-story, daylighted monitor type. The ventilation is adequate and there are no processes which would prevent the use of gasoline motor trucks, so we use them. But we find, too, the electric-battery truck with its freedom from motor maintenance, and perhaps of more flexible control, has a place as well. Our haulage problem is not complex since we have wide aisles, ample head room, a layout which avoids sharp turns, grades and cramped quarters. We planned the buildings so that equipment installation would not be handicapped by such conditions.

A few figures may help to picture the extent of our in- and out-handling. We unload daily an average of 75 carloads of raw and finished material, totaling approximately 2,600,000 pounds. The production schedule of Oakland and Pontiac automobiles calls for more than 1,000 finished cars daily; and dealer shipments balance this production. We endeavor to hold only enough cars in storage to carry us over two non-productive days. Our raw and semi-finished materials are banked to care for from one to six days' supply only; the latter period for small items on which economical delivery can be had only in quantity. There must be efficiency and flexibility in a plan which contemplates volume handling with reserve stocks trimmed to the lowest safe margin.

For assembly of Oakland cars a building was constructed of the same two-floor, monitor type as is used for the assembly of the Pontiac car. This building joins the Pontiac building on the south, being separated by an unloading bay with two lines of track. At the east end of this bay excess stock is housed; it is delivered by an overhead crane fitted with a special sling which handles 10 frames per lift. From storage the frame is carried by lift truck to a multiple drill for drilling motor-support holes, then hung on a monorail and conveyed to the beginning of a cross-travel conveyor, moving across the building at right angles to the final assembly line, on which it is placed inverted.

During its travel along the conveyor, which gives a four-point bearing surface, the frame receives shock absorbers, running-board brackets, cross-shaft assembly, springs, and minor parts. As the frame passes on, the front axle, which is stored on the balcony floor above, is lowered mechanically at the proper point to meet the group assembly. It is then mounted on the springs. Next, the rear springs are trucked from first-floor storage and sub-assembled to the rear axle which is then received by the frame. After inspection, the frame is pushed to an air-powered rack and pinion turnover which rights and places the frame on the power conveyor at the beginning of the final assembly line.

Digressing for a moment—a study of the various conveyor types seems to indicate that they form logical groups from which a proper selection is not difficult. For example, in standardized work where each operation is purely a matter of more or less expert physical co-ordination, the continuous power conveyor is generally indicated; but where there is an uncertainty in the time element, where the mental qualifications of the workman, his resource and ingenuity are called upon, a non-powered conveyor is best used. We find that conveyors used in touch-up or inspection work are most satisfactory when hand operated; but in the main assembly line where each part handled has been inspected and checked, the continuous forward movement acts as a pacemaker and provides a known factor in timing operations.

The Oakland main assembly line, which runs lengthwise of the building, is approximately 1,100 feet long, car storage conveyor included. Normal delivery of finished cars is at the rate of 40 each hour. The flow of material to this line is from both sides, from above, and from below.

Upon transfer to the main assembly chain-conveyor, the frame rapidly begins to take shape as a chassis. The rear cross member is attached, and the frame passes through the spray booth for surfacer. Sequential operations in the assembly then include the universal sleeve, ball-joint, oil filter, air cleaner and then the complete motor.

The assembled motor is delivered from plant No. 5 by trucks equipped with special carrying fixtures, picked up at the unloading dock flanking the east end of the plant, and brought by continuous overhead chain-conveyor to the balcony or second floor—where a bank of switch transfer monorails provides the storage cushion—or

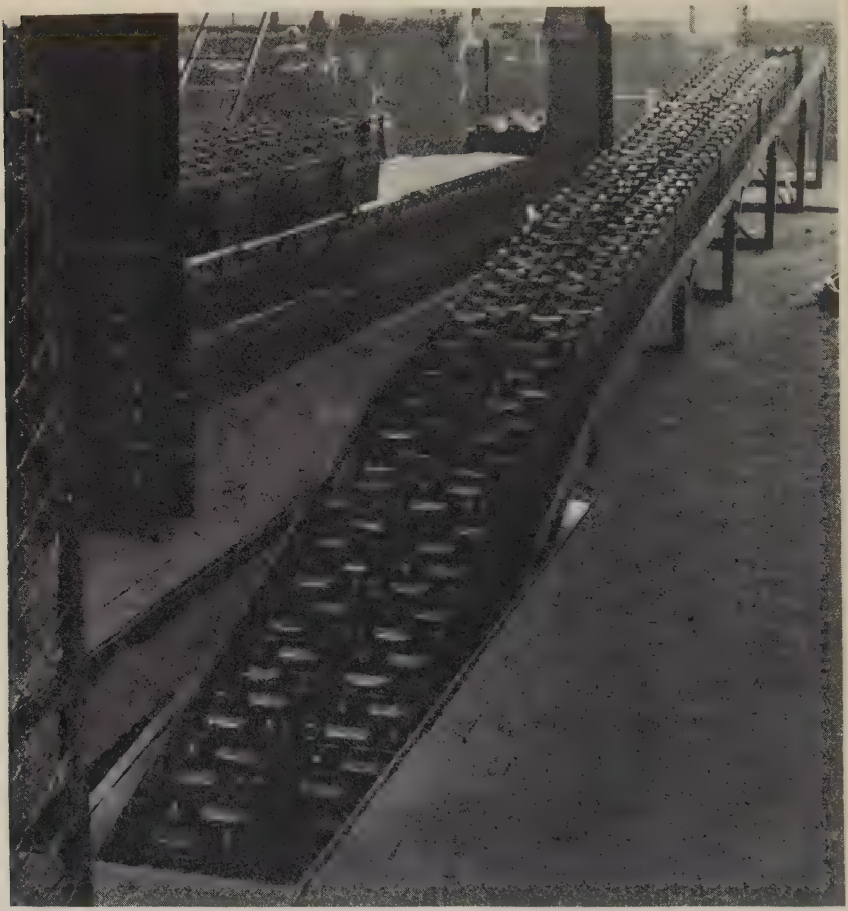


FIGURE 82. *Batteries travel on gravity conveyors and meet the chassis after the wheels are in place. Number 13 shows where they meet the assembly line*

direct to a monorail placed over a hatch through which an electric hoist, dual-controlled from both balcony and floor below, lowers it to the frame. Flexibility and rapidity of manipulation make the electric hoist a valuable tool for operations of this class.

Continuing down the line, oilers, brake rods, gas-tank assembly, and other minor assemblies meet the chassis. In this connection we believe that it is easier to convey parts than to move the subassemblies themselves through various operations; so there are numerous fixtures and small work benches along the assembly line

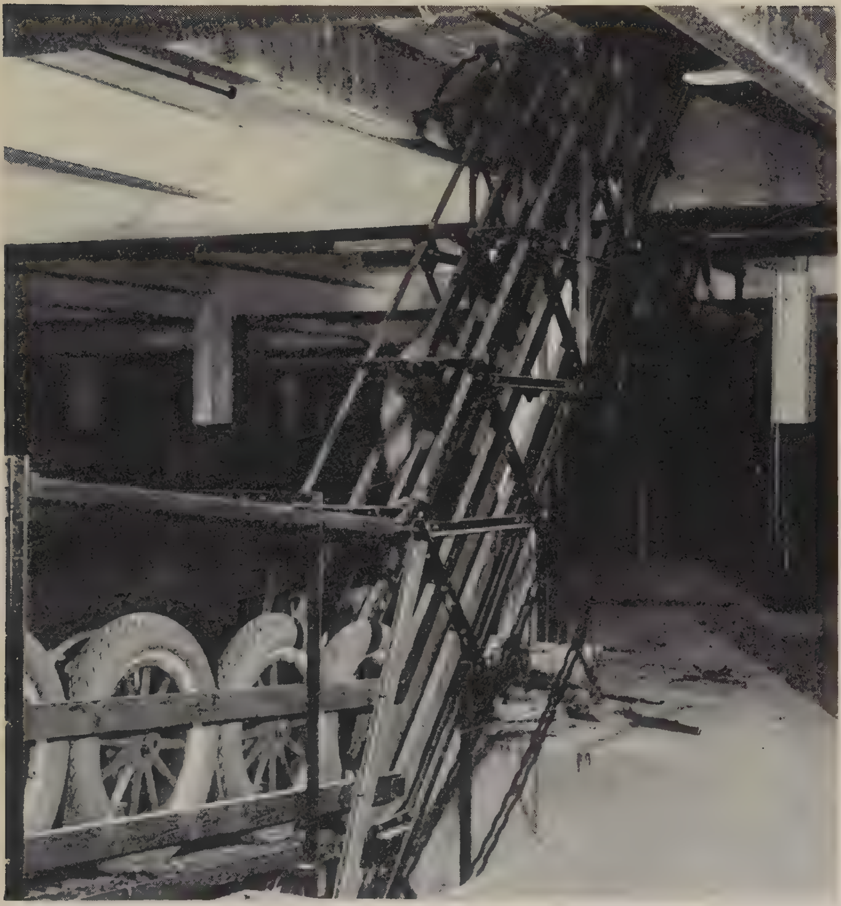


FIGURE 83. *The chassis passes between floor pockets to which run continuous chain conveyors rising from the basement carrying the wheels. This is number 14*

for this sub-assembly work. Finished sub-assemblies flow into the main line at right angles.

When the motor is in place, the chassis has traveled about one-third its total distance. There are in all about 300 scheduled operations for the main assembly line, and each one is continuously scrutinized with respect to its sequence in the line or any factors relative to its application which might be improved. For example, we at one time delivered the battery to chassis after the body drop. We found that changing the point of delivery and placing it just after the conveyor leveled off the "hump," resulted in less installation time and avoided acid splash which might damage the body.

The conveyor next carries the chassis through a spray booth to receive a second touch-up paint coat after which the radiator is set in place.

The plating equipment for the radiator shells offers an example of what may be done in the way of continuous mechanical handling. The process in use pioneers the field in the development of continuous nickel plating. The equipment includes a 60-foot rectangular tank divided into compartments with conveyor equipment mounted on it consisting of load arms or carriers so timed as to lift and immerse the shells in progression through the various stages from copper strike to finish rinse. Twenty manual operations are thus saved for each shell plated. This multiplied by the capacity of the unit, means a good many dollars trimmed from production costs daily.

The enameling plant for fenders, running- and splash-boards, which is installed on the north side of the assembly line and, with its dip tanks and ovens extends almost the height of three floors, has proven a remarkable aid to production. In completing 1,000 cars daily in the two plants 4,000 fenders must be supplied. And this plant by means of continuous conveyors takes the raw parts through a series of dip tanks and drying ovens, gives them the equivalent of four baked-on coats, and spots the parts for use close to the assembly line. The total travel of each part through the system is approximately 1,500 feet.

The pyroxylin finish on the hood is done on revolving platforms in spray booths, however, as this part with the varying colors used cannot well be handled on conveyors. The results accomplished by the enameling plant are not only a saving in dollars, but also they give us a known quantity to reckon with in the flow to production of the parts handled through it.

The steering wheel assembly, muffler, fender arms, running-board brackets have now been placed and the chassis is ready for the fender. Here we depart from the traditional unilevel conveyor, and in doing so solve an annoying problem met in the layout of every automobile plant which contemplates mass production—the application of fenders and running board. These are bulky parts. They are enameled and must be handled carefully. They require floor space and working clearance disproportionate to other car parts.

They are received unfinished and after enameling are delivered to fender storage on the balcony. So we bring our conveyor up an incline, and run it at the second floor level for 50 feet. This is a sufficient distance to complete the assembly of the running board, fender and splash guard, where space is ample and contact with grease, dirt and abrasive material is avoided. Power cost increase, if any—there is of course a gravity pull as well as up-drag—is offset by eliminating most of the haulage and all of the hoistage costs in spotting these parts on the floor below. Another advantage is, that in elevating from the ground floor, a cross highway is provided for trucking.

When the chassis descends on the conveyor from the hump to the floor level, it passes between floor pockets to which run continuous chain conveyors rising from the basement and timed to bring wheel sets up to the assembly line in the sequence which the various car models passing along the assembly line demand. This planning for co-ordination of materials-flow, though an old story to the production executive, is illustrative of the axiom credited to Daniel Boone, "Mix brains with your powder."

Unfinished wheels, rims and tires are received in the basement. The wheels are spray-painted and pushed forward through successive booths on roller devices to meet the tires at the wheel elevators. Tires are mounted on rims, inflated, and carried by continuous overhead conveyor. Here is an interesting contrast in matching equipment to the job at hand. The rim mounting and inflating of a tire soon becomes a standardized operation; the same tools and supplies are used for any tire size. Wheel painting presents a different problem. Colors, striping, and finish, vary constantly. The use of a continuous mechanical conveyor is practical for the one, but for the other the specially designed rack fixture which can be pushed forward through successive operations shows more economy.

After the wheels are in place, the battery is put in the hanger. Batteries cross-flow to the assembly line through a bow-shaped, under-floor, roller conveyor which uses the gravity push of batteries placed on the rollers at the stock-pile to replace those removed at the assembly line. At this point on the line, the air- and electric-operated hand tool comes into its own. We do not discriminate between the two, except to say that for heavy work where speed and portability are minor considerations the air tool will show an

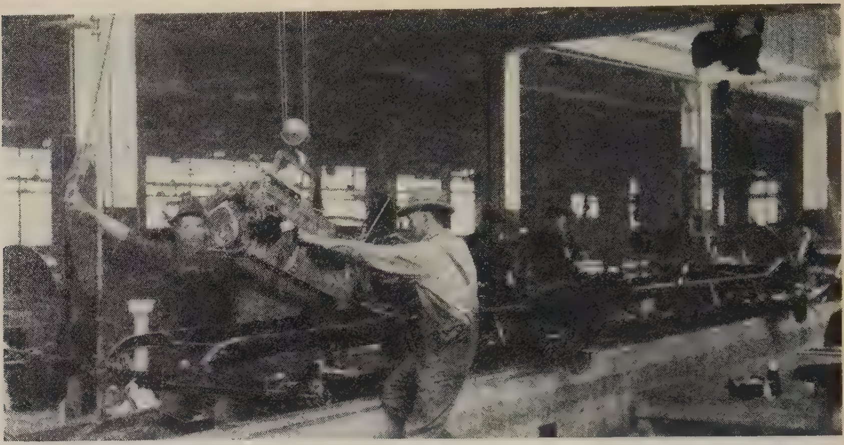


FIGURE 84. *An electric hoist, dual-controlled from above and below, lowers the assembled motor to the frame from the balcony or second floor. Number 7 shows at which point this is done*

advantage; and where these factors are of prime importance, the electric tool is preferable.

With a few minor assembly details completed, the chassis rolls off the chain conveyor, wheel mounted. As its weight will shortly be increased considerably by the body, which might cause undue stress on the tie rod of the car against which the conveyor presses, the chassis rolls ahead off the chain and onto the final car conveyor. This is of slat type and is flush with the floor—a sort of moving sidewalk. This conveyor presents many advantages in that the car may be moved off the conveyor entirely without interrupting the progression of the other cars on the line.

The floor above provides body storage. The open body job is finished on this floor, but closed bodies arrive complete from Fisher plant No. 18 in Detroit, by truck or trailer, and are unloaded into a motor-driven continuous elevator on the east unloading dock at a point adjacent to the terminus of the motor delivery conveyor. The elevator lifts the bodies to the balcony floor. Here they are placed on body pushers and moved into storage near the hatch through which they are ultimately lowered by a dual-controlled electric crane hoist, similar to that used in the motor drop. There are two body assembly conveyor lines on this floor which carry the open body through trim and spray-paint process. Upholstery and trim and cutting departments are also on this floor. Enameling, fender

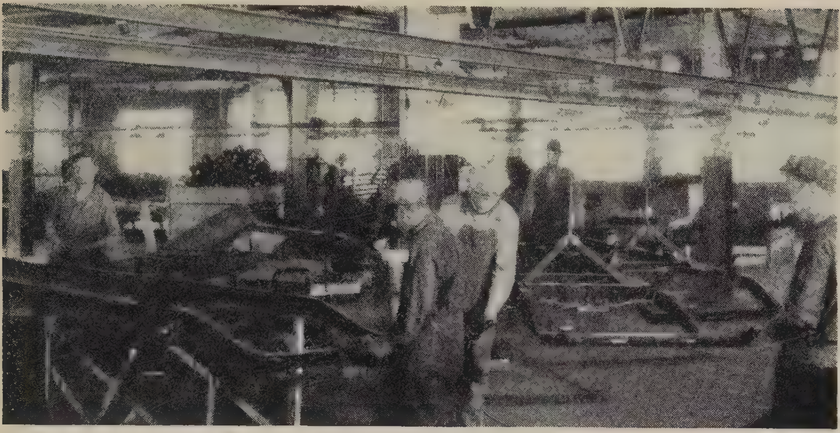


FIGURE 85. *At the start of the long assembly lines. Overhead conveyors bring frames from stock to the line. They are started upside down to permit easy assembly of axles and springs*

and body assembly, and trim, as well as the final fender assembly in the main line, are arranged so that the strictly mechanical processes and those less so are logically divided. This division is made more obvious because the less mechanical processes involve a diverse use of floor area.

Moving down the line, assembly of head lamps, tail light, horn, electrical connections, follow. The vacuum tank, crank case and radiator are then filled at the service station, the motor is started, adjusted, and the car driven off the conveyor under its own power. The hood, trucked from the paint shop, meets the car and is put on here.

The brakes are tested and adjusted over a pit, after the rear axle and transmission have been tested and touch-up painting done. The car is then ready for storage. Should a heavy adjustment be needed the car is delivered to a point ahead of storage where this can be handled.

Cars for freight shipment are run over a pit containing air rams with a hook attached to the plungers to grip and flatten the springs. Springs are held in this position by U-bolts. At the same time, oil, water and gas are drained and heavy steel extension caps—to which blocking may be applied inside the freight car—are substituted for the nickeled caps.

Packing for export requires a variety of methods, as cars are shipped more or less completely disassembled, according to the facilities of the consignee. The work is facilitated by the use of lumber cut to size for the building of each container crate, and we find a liberal use of strapping material economical.

In summary, an impression which the visitor to the Oakland plant gains is that there is surprisingly little evidence of a handling problem in existence. The tractor with its trailer train is not conspicuous. We do use them, but principally for clean-up work and emergency hauls. All along the line, our layout has been planned to minimize handling as a distinct function, and to make it integral with production.

ONCE AROUND THE CLOCK

By HERBERT J. TAYLOR

President, The Club Aluminum Company; Vice-President, Administration Jewel Tea Co., Inc., Chicago

IN a plant with a more complex manufacturing problem and a larger working force it might not be possible. But in one of our plants we manage to turn out, each day, all the orders for coffee received in that morning's and the previous afternoon's mails. We put the material through the production processes, package it, and ship it by quitting time in the afternoon. In consequence, we never have a pound of the finished product in the plant overnight.

This occurs in our coffee-roasting plant at Hoboken. And the process is not so simple, after all, even though we do it with only 48 people. It involves seven successive operations after the bag has been opened and the green coffee dumped, until it is in the packages, ready for shipment.

Our purpose in pushing the work through so rapidly, and in carrying no finished stock on hand, is not alone—not even primarily—to attain a maximum volume on the minimum investment. What we are after is getting the roasted coffee into the hands of our customers, the consumers, just as quickly as can be after roasting. To be sure, we do attain all the advantages of a fast rate of physical turnover. But, compared with shipping fresh coffee, they are incidental with us.

As it happens, coffee constitutes about 55 per cent of the total sales of the company. The other 45 per cent is divided among 53 other items. So coffee is of major consequence in our operation. If we can deliver the best possible coffee to the consumer, we continue to hold her business not only on coffee but also on many of the other items.

Green coffee—unroasted coffee, that is—improves with age until it is about three years old. But roasted coffee begins to deteriorate just as soon as it has been roasted. After perhaps eight weeks, it has lost enough of its aromatic constituents so that it no longer gives results as satisfactory as when it was first roasted.

Perhaps it would be well to describe here, very briefly, our general method of operation as a business. Jewel Tea Co., Inc., belongs in the general chain grocery distributing class, although it is not a chain store organization. Some 1,200 wagon routes, operating out of 78 branches, serve approximately 800,000 customers—housewives—by taking their orders for Jewel products at one call and delivering them two weeks later.

At the Hoboken plant, we roast coffee, and pack tea, rice, and cocoanut. Coffee is the predominant product here. We manage to hold to monthly production schedules on the other items by subordinating their production to the flow of coffee orders. The cushion that the tea, rice, and cocoanut production affords, makes it possible for us to meet the daily orders on coffee, yet to work steady schedules of full days. You see, we use the same people to handle the whole thing, with, in some instances, different machinery.

Branches throughout the country send their weekly orders for coffee to Hoboken. To spread the business through the week, we have given days on which each branch's order must reach the coffee-roasting plant. But, while this spreads the orders throughout the week, it is no insurance against uneven days. It is routine for the plant to run anywhere from 20,000 to 150,000 lb. of coffee in a day. On a 20,000-lb. day it packs a great deal of rice, tea, and cocoanut to take up the slack, while on a 150,000-lb. day everybody is pushed to get out this amount.

Of course, this requires that we have rather more equipment than we could get along with if we ran the plant at a steady rate, turning out an average amount of coffee every day, and taking up the peaks and valleys by carrying a finished stock of packaged product from which to fill orders. But, aside from the primary advantage of shipping absolutely fresh coffee by our present plan, we should also run up our labor costs. It costs money to handle goods into a stockroom and out again. We get away from all rehandling expense by shipping our production every day.

Modern machinery and completely mechanical handling make possible the fast sequence of operations which permits us to handle the coffee through the entire process in a single day.

The bags are emptied into a chute and the coffee goes to the first operation, milling or cleaning, by gravity. After this operation, which consists of rubbing the coffee beans against one another and against the sides of two metal cylinders rotating in opposite directions, while the dust and dirt are sucked off by the air, the coffee is carried by bucket elevators to the next operation, mixing, and blending. This is essentially a tumbling operation, in a cylinder with reverse screw flanges that tumble the beans until they are thoroughly mixed.

From the mixers, the coffee goes by bucket elevators and belt conveyors directly to the roasters. The roasting is controlled by a skilled man who has the assistance of a thermostatic regulator and also of a recording thermometer. Thus he is able to carry the beans from a temperature of 80 deg. F. to 350 deg. at a steady rate during the 23 minutes required for the process.

From the roasters, the coffee is dumped into wire-bottomed cooling pans, through which a blower forces a down-draft of air until the beans are cool enough for the next operation. The cooling pans are on casters to permit easy moving and are so constructed that they can be dumped by one man. They are rolled to a chute and dropped to the floor below.

Here is the stoner, intended to remove any such materials as stones and nails before the grinding. The coffee falls to the bottom of a U-tube and is raised out the other side of the U by suction. This pressure is carefully controlled so that it will lift exactly the weight of a roasted coffee bean, but nothing heavier.

From the stoner, the coffee is blown to a storage bin, from which chutes lead to the packaging machines and to the grinders. Some of the coffee is packaged in the whole bean, consequently it bypasses the grinders. Coffee for grinding is chuted to the grinders.

Ground coffee is carried by screw conveyors to mixing bins above the package machinery. A series of full automatic machines sets up the cartons, inserts the parchment liners, weighs and checkweighs the coffee, seals the cartons, wraps the cartons and delivers them above the fiber shipping containers. Here they are packed and marked for shipment.

Conceivably this plan would not be so easy in a larger plant, with a larger force of employees. But we have succeeded in building up a steady force of 48 people—this includes the clerical workers and maintenance people as well as those on direct production—who are willing and glad to work in our way. We pay a little more than the scale, give vacations of one week after two years and two weeks after ten years, and, in general, accord the sort of treatment that makes a job in our plant far more desirable than the great run of factory jobs.

On our side, we demand that no person in our plant be of the type that says, "That isn't my job." If we want the plant electrician to dump green coffee, we want him to do it just as cheerfully as if his job were regularly dumping coffee. All the way through the plant, people help out on other people's work when there is need. Even our roasters, the most highly skilled production men in the plant, have been known to help load cars when a big day had swamped the shipping facilities—and this in spite of the fact that the roasters had already worked to the limit in turning out so much coffee for shipment.

To make for maximum flexibility, we have developed packages with the maximum of interchangeability. For instance, we pack tea in pounds and half pounds. The tea cartons also handle the rice and cocoanut. A pound tea package is the same as our rice package, except for the label. A half-pound tea package takes a half-pound of cocoanut. So we try to pack our cocoanut while we are running half-pounds of tea, and rice while we are running pounds of tea.

The girls who operate the coffee-packaging machinery also operate the tea-, rice-, and cocoanut-packaging machines. The mechanics who look after the coffee machinery also supervise the other machines. With four coffee-packing lines, we shut down one coffee line when we want to run the tea line. But so far we have never had to get in extra help to run all the lines at once.

This plant shows signs of elasticity as well as flexibility. Last year, for example, we packed more than we packed the previous year. Yet we did it with two less employees—and, for that matter, with almost the identical individuals. The labor turnover here is so low that it is not worth considering.

I do not know that a plant with more complex manufacturing operations could do what we can here. But we suspect that a good many plants could do it, and to their profit, if they only tried.

A PRODUCTION CHECK FOR THE SUPERINTENDENT

OBVIOUSLY a superintendent can't be everywhere at once but it is entirely possible for "everywhere" to be in the superintendent's office at one and the same time!

An example of what is meant is provided at the Williamson Candy Company's plant in Chicago. Ordinary mechanical counters in the superintendent's office have been rigged up with electric magnets so that the counters are distantly operated by contacts on the conveyor which carries boxes of candy bars from the tying machines to the shipping department.

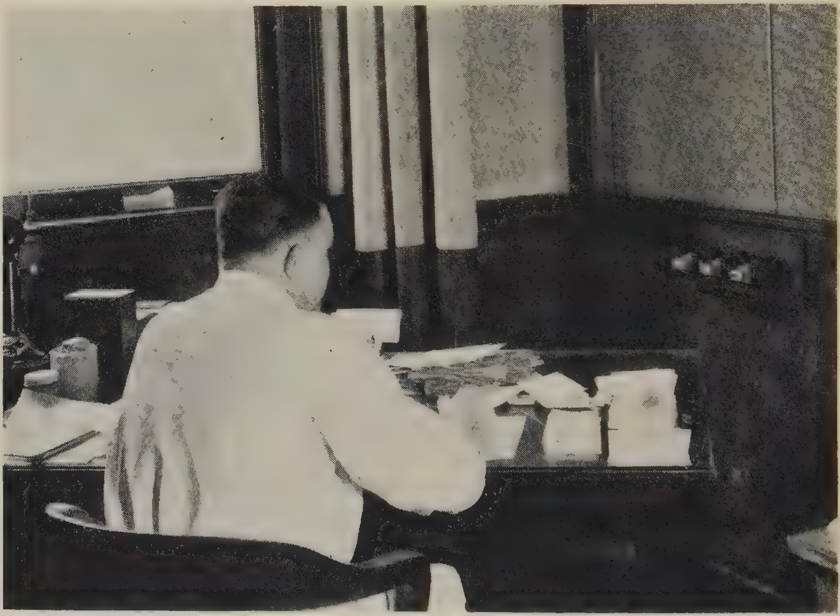


FIGURE 86. *Mechanical counters enable the superintendent to keep his finger on production*

Thus a mere glance, as the superintendent sits at his desk, suffices to report progress, not several hours later, but instantly. Besides this minute-to-minute reporting of progress these counters serve as a check against the figures turned in by the shipping clerk.

GIVE FOREMEN COST DATA

By W. B. NELSON

Office Manager, Factory Accounting, Automatic Electric, Incorporated, Chicago

OPINIONS differ as to the amount of cost information a foreman in a manufacturing plant can assimilate and apply to advantage. Possibly, in the past, foremen have not been sufficiently trained, with occasional exceptions, to use cost information intelligently. But there can be little doubt that the modern foreman can use at least a statement of the operating expenses of his department to good purpose.

Automatic Electric, Incorporated, believes in the policy of informing its foremen of those current expenses of their respective departments which are directly or partially under the foremen's control. For several years, an operating expense statement has been furnished each foreman as soon as possible after the accounting close of business each month. Promptness in getting out this report is one of the essentials to its value as a control aid. This statement is so arranged that monthly totals for each expense classification are directly comparable.

This report made up by the factory accounting department is given to the foreman each month, and is returned by him after perusal, so that the accounting department can post the figures for the following month.

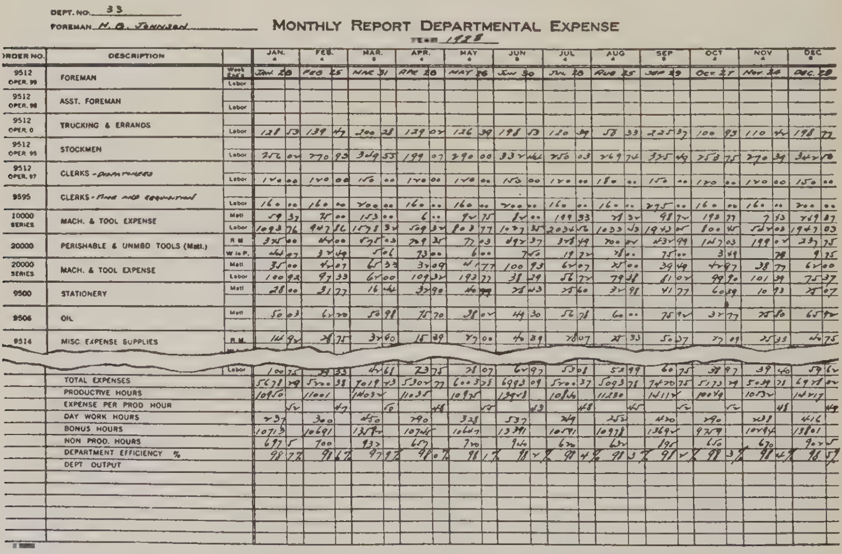
The expenses of each department are budgeted, so that each foreman is given a predetermined figure at which to aim. If he can operate his department without sacrificing output or quality of work, and can finish the year with an expense outlay under his budget, he has done a good job.

A monthly expense conference of foremen is held with the superintendent of manufacture, during which the departmental expenses are discussed. The meetings are held by groups of related departments, to keep the number of men in each group small enough to make the conference informal. Each foreman feels free to bring up any of his problems so far as they relate to overhead expense. The various expenses of a selected department are compared with a previous month and fluctuations call for an explanation from the foreman involved.

Expense reports go out to the foremen about a week before the conference is called, to allow for investigation of items that look out of line, and preparation of individuals who may be called on in the meeting.

The chief value of these conferences is that they keep the foremen thinking about expense and awake to any opportunities to make expense reduction. Foremen are more careful to see that expense materials which they requisition are sufficient only for current needs, resulting in a better control of the supply inventory and a minimum waste. In doing work for other departments, the foreman is careful to keep the cost of the work down to a reasonable figure, lest he be called on for an explanation by one of his associates in the conference.

This program is not aimed at making the foreman "penny wise." It has a sounder aim: that of providing an adequate expense control and insuring a dollar's worth of results for each dollar expended. It is always difficult to determine the amount of direct savings attributable to such a program, but it is safe to say that it has had an important share in the substantial reduction in the ratio of expense to output, which has been obtained during the period since its inauguration.



DEPT. NO. 33
FOREMAN H. B. Johnson

MONTHLY REPORT DEPARTMENTAL EXPENSE
YEAR 1928

ORDER NO.	DESCRIPTION		JAN. 4	FEB. 4	MAR. 5	APR. 4	MAY 4	JUN 5	JUL 4	AUG 4	SEP 5	OCT 4	NOV 4	DEC 5
9512 OPER. 99	FOREMAN	Week Ends	Jan 28	Feb 25	Mar 31	Apr 28	May 26	Jun 30	Jul 28	Aug 25	Sep 29	Oct 27	Nov 24	Dec 29
		Labor												
9512 OPER. 98	ASST. FOREMAN	Labor												
9512 OPER. 0	TRUCKING & ERRANDS	Labor	128 53	139 47	200 28	129 02	136 39	198 53	120 39	58 33	225 37	100 93	110 42	198 77
9512 OPER. 95	STOCKMEN	Labor	256 02	270 93	349 55	199 07	290 00	332 46	250 03	269 74	335 49	253 75	270 39	342 50
9512 OPER. 97	CLERKS – Dispatchers	Labor	120 00	120 00	150 00	120 00	120 00	150 00	120 00	180 00	150 00	120 00	120 00	150 00
9595	CLERKS – Time and Requisition	Labor	160 00	160 00	200 00	160 00	160 00	200 00	160 00	160 00	275 00	160 00	160 00	200 00
10000 SERIES	MACH. & TOOL EXPENSE	Mat'l	59 37	75 00	153 00	6 00	92 75	12 00	199 33	78 32	98 72	198 77	7 43	269 87
		Labor	1093 76	947 86	1578 32	509 32	808 77	1027 35	2036 56	1033 43	1942 05	800 45	524 08	1947 03
20000	PERISHABLE & UNMBD TOOLS (Mat'l.)	R.M.	325 00	42 00	575 03	729 35	77 03	492 37	378 49	700 05	432 99	147 03	199 02	237 75
		W in P.	44 07	32 49	5 06	73 00	6 00	7 50	19 72	78 00	75 00	3 49	78	9 75
20000 SERIES	MACH. & TOOL EXPENSE	Mat'l	35 00	42 07	65 33	32 09	41 77	100 95	62 07	25 00	39 49	42 97	38 77	62 00
		Labor	100 92	97 33	62 00	109 32	193 77	31 29	56 72	79 38	61 02	99 90	101 39	75 37
9500	STATIONERY	Mat'l	28 00	31 77	16 44	32 90	46 77	28 43	25 60	32 98	41 77	60 39	10 93	25 07
9506	OIL	Mat'l	50 03	62 20	50 98	75 70	38 02	44 30	56 78	60 00	75 92	32 77	25 50	65 92
9514	MISC. EXPENSE SUPPLIES	R.M.	14 92	28 75	32 60	15 39	27 00	40 39	76 07	25 33	50 37	77 09	25 33	46 75
		Labor	100 75	39 33	46 61	23 75	28 07	62 97	53 08	52 99	60 75	38 97	39 40	59 62
	TOTAL EXPENSES		5678 29	5200 38	7019 43	5302 77	6003 78	6993 09	5200 37	5093 78	7470 75	5173 29	5039 71	6978 02
	PRODUCTIVE HOURS		10950	11001	14032	11035	10925	13948	10846	11230	14112	10049	10532	14217
	EXPENSE PER PROD. HOUR		52	47	50	48	55	43	48	45	52	52	48	49
	DAY WORK HOURS		237	300	250	290	328	537	249	252	420	290	238	416
	BONUS HOURS		10713	10691	13782	10745	10647	13391	10591	10978	13692	9759	10294	13801
	NON PROD. HOURS		697 5	700	932	657	710	940	620	652	795	650	670	902 5
	DEPARTMENT EFFICIENCY %		98 7%	91 6%	97 9%	98 0%	98 1%	98 2%	98 4%	98 3%	91 2%	98 3%	98 4%	98 5%
	DEPT. OUTPUT													

FIGURE 87. *This report shows the foreman, month by month, the actual detailed costs of running his department. After he has had ample opportunity to examine it carefully, it is discussed in full, along with the reports for other departments, at a monthly expense conference*

OUR TRUMP CARDS TAKE THE HUMAN ERRORS OUT OF PRODUCTION CONTROL

By R. P. JACKSON

Factory Superintendent, Addressograph Company, Chicago

THE old adage about the shoemaker's children going barefoot no doubt has wide application throughout industry, but it cannot with justice be used apropos of our product nor of the plant where we make it.

The reason is that we use our own addressing and data writing equipment in our own production control work. Nor did we force the issue and make the installation under pressure of considerations other than those of facilitating our manufacturing operations.

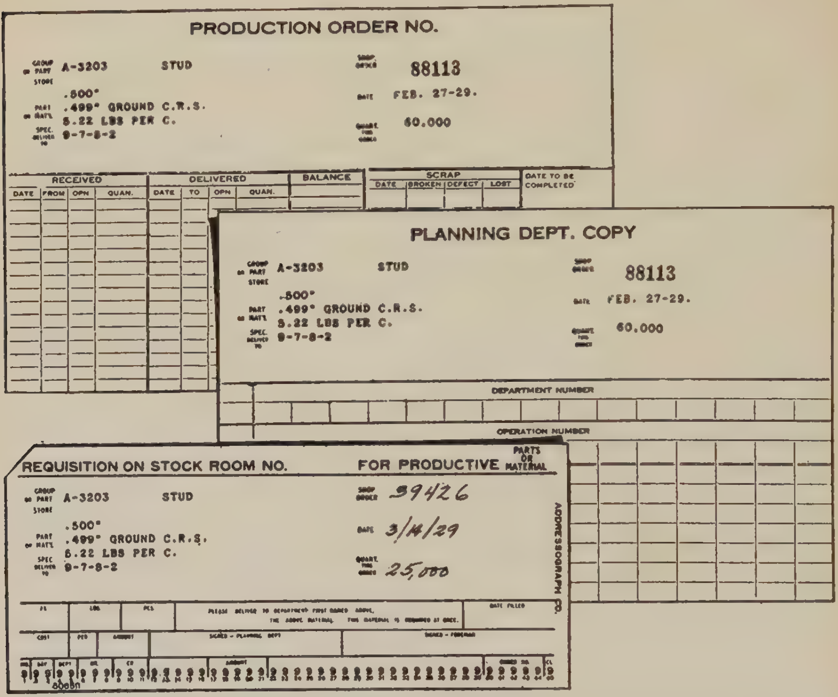
We honestly felt that it would eliminate costly errors, speed up production, reduce clerical costs, increase the productive time of operators, simplify payroll and cost recording, and provide perfect legibility on all factory forms. Not the least of the advantages is that it releases our technical men almost entirely from routine clerical effort which previously occupied much of their time.

That we were right on every one of these points, our tests have proved.

While the plan is flexible enough to allow its being fitted to a wide variety of manufacturing conditions, it is described here as designed for our own particular requirements.

We in the production end of our business feel, I suppose, just about as other production people do, in that we didn't want some piece of mechanical equipment forced upon us, disturbing a procedure which we had established after much thought and as a result of years of experience. But we did not find it necessary to undergo any revolutionary changes to make use of this new method of writing our forms. We appreciated that in this plan was the germ of a valuable idea and we adapted it to our existing production planning methods.

The idea which we bent to our needs is simply this: All of our master production data such as, routings, material specifications, piece rates, operation descriptions and drawing numbers, which we had been carrying on numerous paper records, we transferred to embossed master card index plates. These plates constitute not only an unusually safe and convenient record file from a reference standpoint but they also transcribe themselves on all our factory



PRODUCTION ORDER NO.

GROUP OR PART STORE A-3203 STUD
.500"
PART OR MAT'L .499" GROUND C.R.S.
5.22 LBS PER C.
SPEC. DELIVER TO 9-7-8-2

SHOP ORDER 88113
DATE FEB. 27-29.
QUANT. THIS ORDER 60.000

RECEIVED				DELIVERED				BALANCE	SCRAP				DATE TO BE COMPLETED
DATE	FROM	OPN	QUAN.	DATE	TO	OPN	QUAN.		DATE	BROKEN	DEFECT	LOST	

PLANNING DEPT. COPY

GROUP OR PART STORE A-3203 STUD
.500"
PART OR MAT'L .499" GROUND C.R.S.
5.22 LBS PER C.
SPEC. DELIVER TO 9-7-8-2

SHOP ORDER 88113
DATE FEB. 27-29.
QUANT. THIS ORDER 60.000

DEPARTMENT NUMBER

OPERATION NUMBER

REQUISITION ON STOCK ROOM NO. FOR PRODUCTIVE PARTS OR MATERIAL

GROUP OR PART STORE A-3203 STUD
.500"
PART OR MAT'L .499" GROUND C.R.S.
5.22 LBS PER C.
SPEC. DELIVER TO 9-7-8-2

SHOP ORDER 39426
DATE 3/14/29
QUANT. THIS ORDER 25,000

FIGURE 88. *We transferred production data, which we had been carrying on paper records, to master plates, one plate for each standard part*

forms 20 to 30 times faster than they can be copied by hand—and without the possibility of error. This mechanical copying is, of course, performed on an addressing machine, the embossed master record plates printing through a ribbon.

The absolute accuracy of this method as compared with hand copying was a most important factor, for we have many symbols and numbers to reproduce on our production forms, and errors in copying this sort of material by hand frequently creep in.

As worked out in our plant we have in our production planning department a complete file of metal card index address plates—one master plate for each standard part. Then in the various making departments are operation plates for each operation involved in the construction of the respective part.

The master plate is indexed by a label tab and is filed numerically according to part number. The plate itself is embossed with the following information:

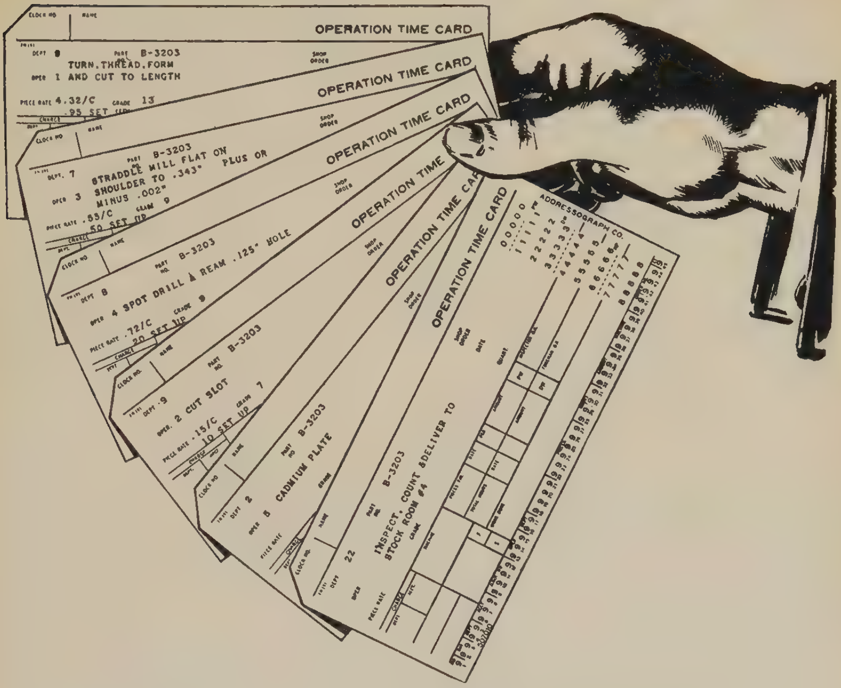

OPERATION TIME CARD
CLOCK NO
NAME
DEPT 8
PART NO B-3203
SHOP ORDER
OPER 1 TURN. THREAD. FORM AND CUT TO LENGTH
PIECE RATE 4.32/C
GRADE 13
.95 SET UP
CHARGE
DEPT
DEPT. 7
OPER 3 STRADDLE MILL FLAT ON SHOULDER TO .343" PLUS OR MINUS .002"
PIECE RATE .53/C
GRADE 9
.50 SET UP
DEPT 8
OPER 4 SPOT DRILL & REAM .125" HOLE
PIECE RATE .72/C
GRADE 9
.20 SET UP
DEPT 9
OPER. 2 CUT SLOT
PIECE RATE .15/C
GRADE 7
.10 SET UP
DEPT 2
OPER 5 CADMIUM PLATE
DEPT 22
INSPECT. COUNT & DELIVER TO STOCK ROOM #4
DATE
QUANT.
ADDRESSOGRAPH CO.

FIGURE 89. *Time cards to the number required are imprinted from plates kept in operating departments*

Part name and number.

Drawing number,

Storeroom number, including even the aisle and bin numbers,

Materials specifications and sizes,

Numbers of the operating departments involved in the exact order in which the operations occur.

The operation plates, which as already explained are located out in the various production departments, are embossed as follows:

Department number and part number,

Operation number and description,

Piece rate, if any, and the grade of labor, if any.

Additional information regarding the order, such as the shop order number, date and quantity, is carried in the so-called auxiliary printing attachment in the addressing machine, at the right of the printing position of the plate itself. Thus the shop order number is set upon a number attachment, the date is fastened in the printing position and the small quantity plate, which gives the number of parts to be put through, is held in place by permanent magnets.

The operation plates are kept out in the operating departments instead of in the central production planning department because it is never possible to predetermine the exact number of forms required until the operation is actually performed. For example, take time cards which are run off from these plates. Some operations will be of such length as to require only one card, while other operations may require a dozen or more.

The time clerk in the working department involved imprints the time cards and other forms on a small hand-operated addressing machine right in his own department.

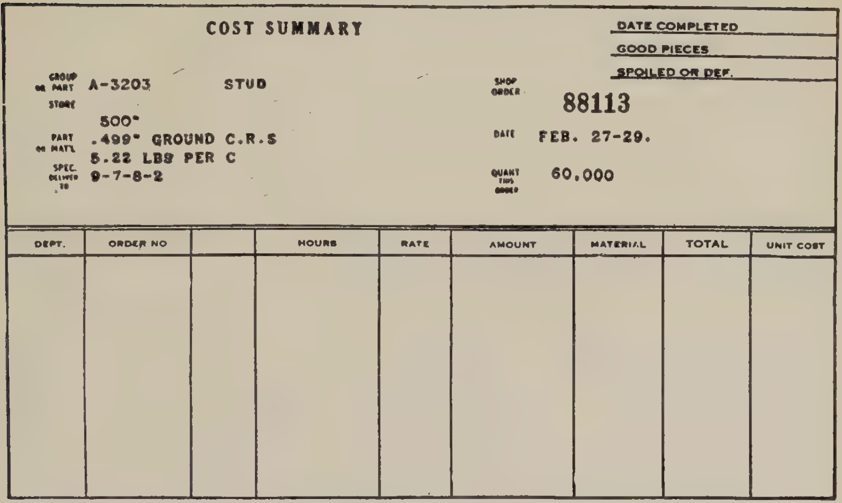
Now let us look at the individual forms and note the part which each plays. First comes the production order card, which also serves to give routing information, instructions and authority to produce. This is what initiates the order. It is made out in the production planning office from the master plate. One card is imprinted for each department involved. Before printing, the shop order number is set up on the number attachment and the plate which imprints the quantity desired is inserted into position. And the date plate is set in place at the beginning of each day.

The production order card authorizes the production of a certain part, gives all the necessary instructions as to manufacture, and routes the work through the factory.

The next form printed from the master plate is the planning department copy, which is a tracing record. This is a fairly heavy manila card, 5 by 8 inches in size, and is filed in the planning department by order number. Its function is to contain the postings made daily as the respective operation time cards are sent in by the various factory departments at the end of each day. By these means the planning department knows at all times just what progress each shop order is making through the plant.

The third form to be imprinted from the master plate is the requisition for parts or production material. This form is imprinted in duplicate. The original is printed on a carbon-backed oversheet and the duplicate carbon copy is a standard tabulating machine card, yellow in color.

All of the necessary information is imprinted from the plate and the auxiliary printer. The total amount of all material required for any particular job is obtained by multiplying the number of parts



COST SUMMARY

DATE COMPLETED
GOOD PIECES
SPOILED OR DEF.

GROUP OR PART A-3203 STUD
STORE
SHOP ORDER 88113
PART OR MAT'L 500" .499" GROUND C.R.S 5.22 LBS PER C
DATE FEB. 27-29.
SPEC. DELIVER TO 9-7-8-2
QUANT THIS ORDER 60,000

DEPT.	ORDER NO		HOURS	RATE	AMOUNT	MATERIAL	TOTAL	UNIT COST

FIGURE 90. *Direct labor and material costs for each part are tabulated on a summary card imprinted from the master plate*

called for in the order by the factor which is printed from the master plate.

The planning department clerk makes the extension and writes in the total at the same time he fills in the number of the storeroom to which the requisition is directed. If more than one item of material is required, both items may be carried on the same master plate providing they are both issued by the same storeroom.

The carbon-backed oversheet is delivered with the stock to identify it, and it may be utilized for the foreman's receipt to the storeroom.

After serving its purpose in the storeroom the tabulating card itself is forwarded to the planning department for posting on the stock ledger. It is then passed on to the cost department for the material cost record. This latter point will be more fully explained later.

With the exception of the cost summary card, which also will be mentioned later, this completes the forms which are run off from the master card.

Now let us look into the functions of the operation plates. These are kept filed in the respective making department by part numbers. When an order comes into a department the time clerk takes the plates involved from the file and puts them temporarily in an active file which serves as a planning board for work in process. Thus they are immediately accessible at any time. After they have served their purpose they go back into the permanent file.

When an order reaches the department in question there are printed *as needed* the time tickets from the respective operation plates, as has already been mentioned. And from the same plates are run off the various record forms for department use. The same plate may be used for printing more tickets where they are employed, although we do not use them.

Each night all time cards representing completed operations or partially completed operations are forwarded to the planning department. After the progress has been recorded on the planning department records, these time cards are turned over to the payroll department and wage amounts are extended, and the wage amount, worker's number, shop order number and other necessary data are punched for tabulating.

In the tabulating machine these cards are first sorted by clock numbers so that wages may be computed for the payroll and then are sorted by shop order number for purposes of figuring the labor costs of the job.

The other form to be run off from the operation plate is a 3¼ by 7½ inch manila record of department receipt and delivery. This is a memorandum form. One each is provided each foreman for each operation. It serves to record receipts of material in process from the preceding department and deliveries to the following department. When final delivery is complete the foreman obtains the next foreman's signature as receipt. Thus his record is cleared and he is in a position to furnish tangible evidence of the performance of his operation.

Now let us get back to the cost summary card which has already been mentioned. This 5 by 8 inch manila card is run off from the master plate in the planning department at the same time the other forms are printed. As previously explained, the direct labor costs are calculated from the operation time card after they have been sorted by shop order number. This cost summary card is then inserted in the tabulating machine and upon it is tabulated a complete summary of labor costs from the operation time card.

Similarly material costs are obtained and tabulated on this summary card. By counting the number of operations shown at the head of the summary card the cost department knows how many operation time cards they should have. Thus a careful check for completeness is possible before tabulating. Similarly materials requisitions are checked.

Since this method of computing material and labor costs is entirely mechanical it is far more accurate than hand work. And the procedure is economical because one tabulating machine with the assistance of the addressing machine can do quickly and easily the work of many clerks.

When it comes to the assembly of completed work the procedure is almost the same as that already described except that the details are changed to suit the needs of this kind of work.

We make another use of the plates which should be mentioned. Once only, at the time the plates are made, route sheets are run off on the listing attachment of the addressing machine. These are used for reference purposes and are kept in binders in the various departments. They serve to inform the department head of the routing of the work, not only through his department but also in the preceding and subsequent departments, so that he can find out at any minute just where a given job may be, and arrange the schedules for his own department accordingly.

LOOK WHERE YOU'RE GOING
VISUAL CONTROL OF PRODUCTION CYCLES

By W. B. NELSON

Office Manager—Factory Accounting, Automatic Electric, Inc., Chicago

THE problem of obtaining positive control of a manufacturing organization from a production and cost point of view, without red tape or endless paper work, is a hard one to solve. How the American Electric Company, Incorporated, Chicago, manufacturers and distributors of telephone apparatus, attained this end is the substance of what follows.

The fundamental plan was to group the work of each production center so that the operators in each group formed a producing unit and could be paid on that basis. Along with this went the development of a production-control board to provide for scheduling and controlling the output of each group as simply as it could be done.

The plant had been operated for some time on the ordinary job-order basis with the operators on individual bonus (piecework with a guaranteed day-wage rate). During this period manufacturing

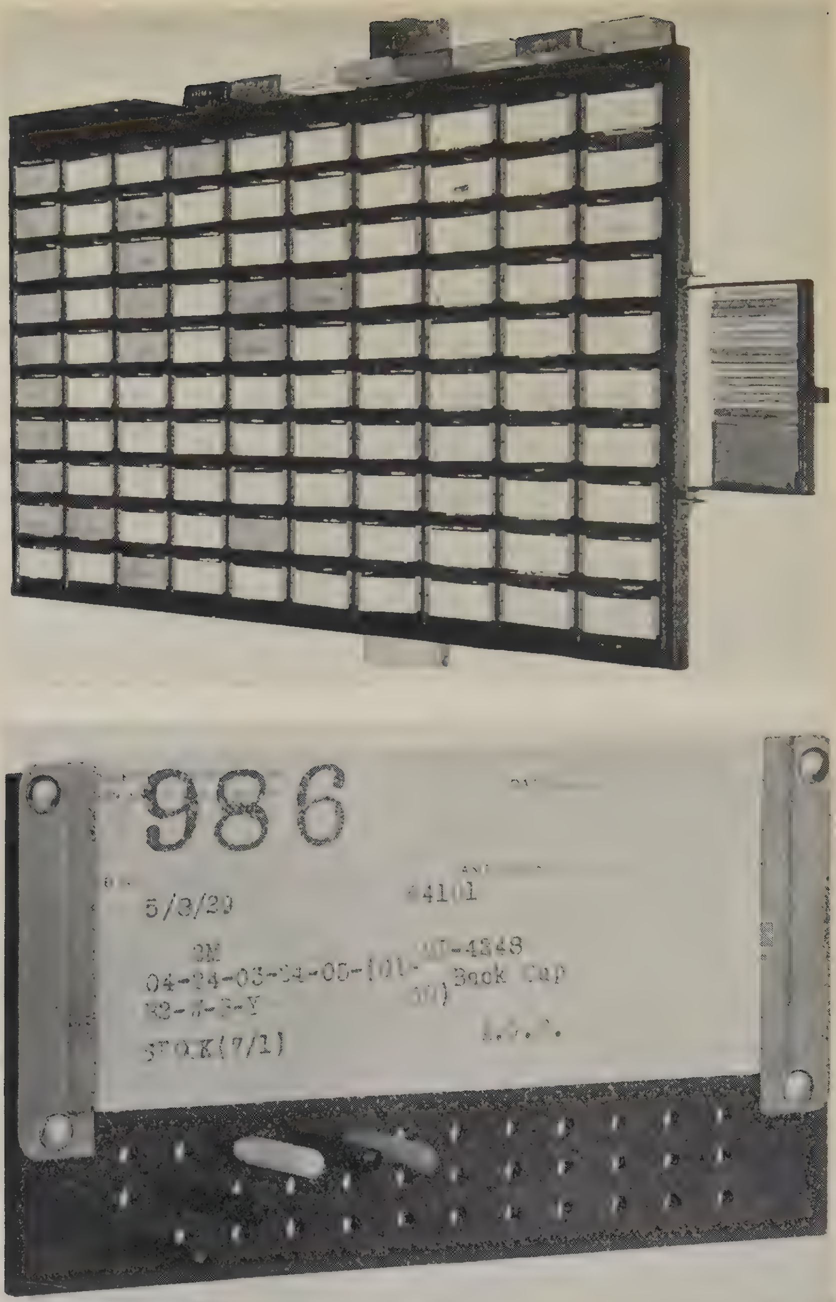

986
5/3/29
4101
Back Cap

FIGURE 91. *A visual check on production beats written records. The colored pegs on the control board show just how far a job has progressed*

data, consisting of operation layouts, shop drawings, and bonus rates based on time studies, were accumulated. With this data as a background, the new plan was worked out.

It might be well to deviate at this point to describe these manufacturing data, for without them no form of adequate control is possible.

The manufacturing layout for a part made from raw material consists of shearing information, material requirements per thousand parts, an operation and department route list giving a condensed description of each operation and the tools required to complete it, and finally, the finish which the part is to receive.

The layout is adhered to strictly to insure a uniform product. It may be changed, however, with improved methods of manufacture.

The shop drawing or blueprint gives a working sketch of the part, complete information as to dimensions, limits, finishes and so on. It, together with the layout, furnishes all the information which the shop requires to make the part.

The rate card for each operation gives a detailed description of the operation, the standard output per hour and the price per thousand to be paid for completing the work described therein.

In proceeding with the new plan the decision was reached to consider the entire machine department as one producing unit with sub-units—punch press, drilling, milling, and screw machine—under supervisors who were at the same time the set-up men for their respective sub-units.

The control board, physically, is a metal frame upon which are mounted 100 small sections (Figure 91) in rows 10 wide and 10 high. The sections are demountable, being attached to the frame by means of screw heads which slip into bayonet slots on the frame. Each section consists of a card holder and three horizontal rows of small holes into which pegs may be inserted. The upper row of holes represents operations to be performed; the middle row, operations set up; and the lower row, operations in work.

The card holder holds a 2x5-inch card which carries the piece number of the parts to be made, the serial number representing position on the board, the cost-control number, the route, and quantity to be made. This card also serves as a move ticket and stock transfer for the completed parts.

When the production planner assigns a part to a position on the control board he sets up the pegs in the upper row of holes to represent the operations through which the part is to go, with pegs of one color to indicate punch-press operations; another, drilling operations; and so on.

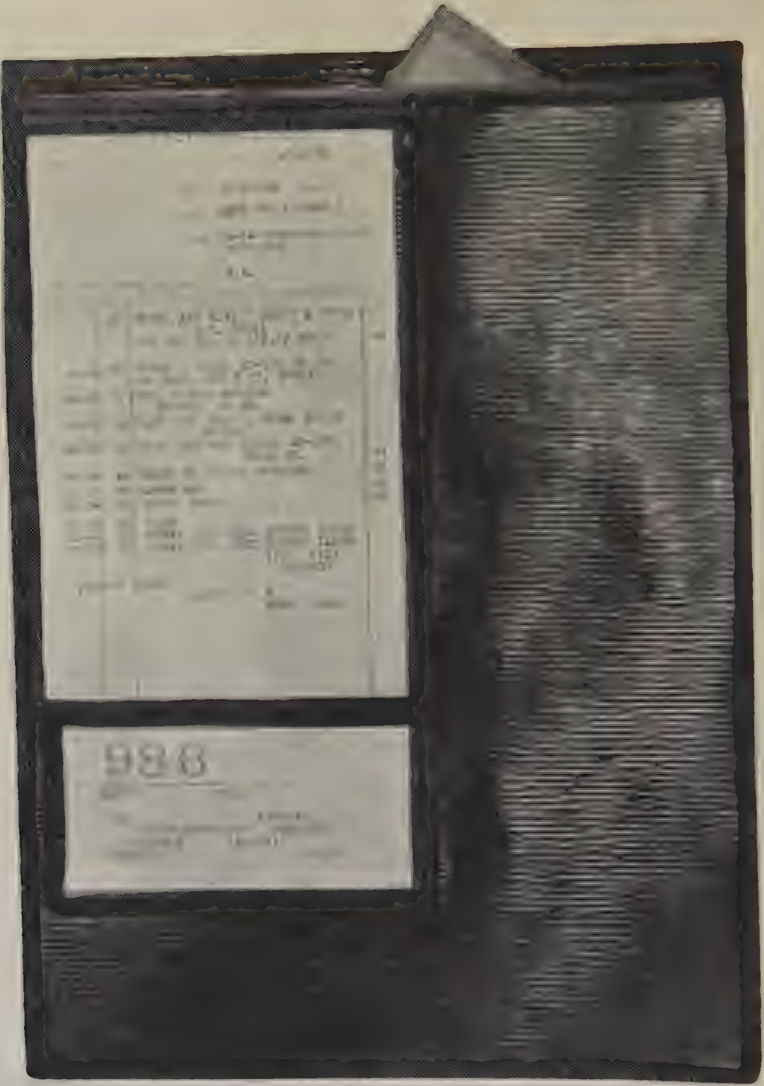


FIGURE 92. *Layout, blueprint and schedule card float with material through the various operations. A pocket with "windows" keeps them clean*

The planner cannot assign a job to the board until he has seen that the material required has been delivered to the machine department. He accomplishes this by routing a requisition to the raw material storeroom together with a pocket into which the layout, blueprint, and schedule card have been inserted.

This pocket (Figure 92) is large enough to permit the blueprint to be placed inside while the layout card and schedule are slipped into smaller pockets on the outside with transparent celluloid fronts through which the information may be read without removing the cards. This arrangement also serves to keep the manufacturing data clean. These records float with the material through the various operations until the parts are completed and are then returned to file until needed for the next lot going through.

When the first operation on the part is set up, the set-up man moves the peg representing that operation from the upper to the middle row of holes; and when it is running, moves the peg to the lower row. The supervisor for the group of machines involved in the next operation then knows that the part is in work on the operation just preceding his and he prepares the next available machine for running this particular part.

As the first operation is completed, the peg is removed from the lower row of holes. In the meantime, the set-up man has selected another part for the machine just released and the process is repeated. As the final operation is completed the parts are moved to the inspector and the cycle of operations, as far as the machine department is concerned, is complete.

The planner's problem is merely to arrange his assignment of jobs to the control board in accordance with his requirements in the assembly departments, and the rest of the process takes care of itself.

Once a position on the board is assigned to a part, the planner is not permitted to change it. He is allowed, however, when a particular part is urgently needed, to place a piece of blue transparent celluloid over the card to indicate that special action is necessary. The set-up men give these blue schedules preference. At any time, the number of blue schedules on the board reflects to a considerable extent the efficiency of the production department in the controlling and scheduling of requirements.

Tied in with this system of visual control is a group bonus plan.

The time-study department prepared rates for each part to cover all the machining operations, one rate for each part, and made a study of the past performance of each operator who had been on the individual bonus basis. From this study an assumed day-wage rate, hereinafter called the preferred rate, was established for each individual to be used as a basis for distribution of the bonus earned by the group as a whole. This preferred rate does not necessarily remain fixed but as the time-study department's investigations indicate that an operator's performance entitles him to share in the bonus earned at a higher ratio, his preferred rate is changed accordingly.

A tally sheet (Figure 93) records the output of the group from day to day for each week with only the completed good parts being entered. This sheet is filled in by the inspector who also counts the parts.

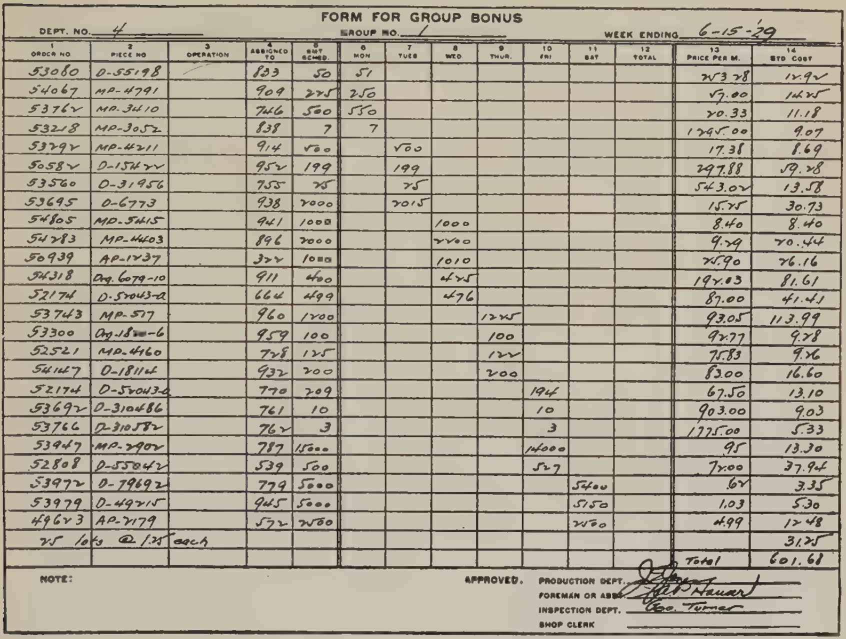
Since the operators receive credit only for the good parts produced, defective workmanship is controlled by the workmen themselves. Together with strict inspection of raw materials, quality control is obtained, with a minimum of process inspection and scrapped parts.

The time keeping for the employees in the group is reduced to the writing of one ticket per week, for each operator, to represent the number of hours with which the group is to be charged.

At the end of each week the tally sheets are priced, extended, and totaled to obtain the amount with which the group is to be credited. The difference between the earnings as represented by the tally sheets and the day wages paid to the operators in the group is the bonus earned. It is distributed to the various operators on the basis of their preferred day wages (hours worked multiplied by preferred rate).

It is obviously impossible to control the flow of work through the department so that the total earnings of the group will be constant each week. In order to prevent wide fluctuations in the earnings from week to week, a bonus reserve has been established. Excessive earnings for a week in which an unusual number of parts pass through the final operations go into this reserve, and withdrawals can be made from it to fill in on those weeks of relatively low output.

These remarks have been confined to the machine group as illustrative of the plan as established, but they apply equally well to the



FORM FOR GROUP BONUS

DEPT. NO. 4 GROUP NO. 1 WEEK ENDING 6-15-29

1 ORDER NO.	2 PIECE NO.	3 OPERATION	4 ASSIGNED TO	5 AMT. SCHED.	6 MON	7 TUES	8 WED.	9 THUR.	10 FRI	11 SAT	12 TOTAL	13 PRICE PER M.	14 STD COST
53080	0-55198		833	50	51							253.28	12.92
54067	MP-4791		909	275	250							57.00	14.25
53762	MP-3410		746	500	550							20.33	11.18
53218	MP-3052		838	7	7							1295.00	9.07
53292	MP-4211		914	500		500						17.38	8.69
50582	D-15422		952	199		199						297.88	59.28
53560	0-31956		755	25		25						543.02	13.58
53695	0-6773		938	2000		2015						15.25	30.73
54805	MP-5415		941	1000			1000					8.40	8.40
54283	MP-4403		896	2000			2200					9.29	20.44
50939	AP-1237		322	10[illegible]			1010					25.90	26.16
54318	Dwg. 6079-10		911	400			425					192.03	81.61
52174	D-52043-a		664	499			476					87.00	41.41
53743	MP-517		960	1200				1225				93.05	113.99
53300	Dwg-18[illegible]-6		959	100				100				92.77	9.28
52521	MP-4160		728	125				122				75.83	9.26
54147	0-18114		932	200				200				83.00	16.60
52174	0-52043-a		770	209					194			67.50	13.10
53692	0-310486		761	10					10			903.00	9.03
53766	D-310582		762	3					3			1775.00	5.33
53947	MP-2902		787	15000					14000			95	13.30
52808	D-55042		539	500					527			72.00	37.94
53972	D-79692		779	5000						5400		.62	3.35
53979	D-49215		945	5000						5150		1.03	5.30
49623	AP-2179		572	2500						2500		4.99	12.48
25 lots @ 1.25 each													31.25
												Total	601.68

NOTE:

APPROVED. PRODUCTION DEPT.
FOREMAN OR ASST. Hauert
INSPECTION DEPT. Geo. Turner
SHOP CLERK

FIGURE 93. *The difference between the earnings recorded on the tally sheet and the day wages paid to operators in the group is the bonus earned*

assembly groups which are operating on the same basis. The problem of requisitioning material to the assembly group is somewhat different, but the fundamental plan for production control is essentially the same.

Some of the results obtained from the operation of this plan as compared with ordinary job-order scheme may be enumerated as follows:

1. The cost of supervision is reduced. The set-up men are the supervisors of their respective machine groups.

2. Planning is simplified. The control board shows the status of the department at any time.

3. Time keeping is simplified. The checking in and out on individual operations is eliminated.

4. Clerical work is reduced to the minimum. No progress records
5. The foreman has time really to supervise his department.
are required.

When information regarding any of the work is desired, the individual goes to the control board and gets it, without interrupting anyone.

6. Costing the output is simplified. One entry from the tally sheet gives the total labor expended on any job.

7. Defective workmanship is practically eliminated. The operators are not paid for defective work.

8. The group spirit is introduced, with all the employees in the group working together to produce quality work in the shortest possible time.

PRODUCTION CONTROL—A JOB FOR EVERY MAN IN THE PLANT

By GUSTAV STIEGLITZ
Vice-President, Indiana Limestone Company, Bedford, Indiana

CUTTING stone according to plans and specifications is an operation similar in many respects to machining castings in a job machine shop. It involves an enormous amount of detailed, close control. Yet if you were to walk through one of the shops of the Indiana Limestone Company you would see few evidences of clerical control. There are no elaborate planning boards, no material chasers flying hither and yon.

When the company consolidated the properties of 24 producers, three years ago, and put these mills and quarries under a single management, these units were for the most part operating fairly efficiently from a production standpoint. They were manned by some of the best stoneworkers in the world, some of them sculptors and artists and many of them craftsmen of the highest order.

Production control was simple and direct. When an order was received and had been broken down into the individual stone drawings and specifications needed for production, the mill manager put it into work and made it the responsibility of the foreman. The mill manager was in constant contact with the customer on important work, and made it his business to see that jobs were started and put through in the right order. There was little crowding of the men, little outside follow-up in the shop. Each foreman, having the sole responsibility for getting out his part of the work, saw to it

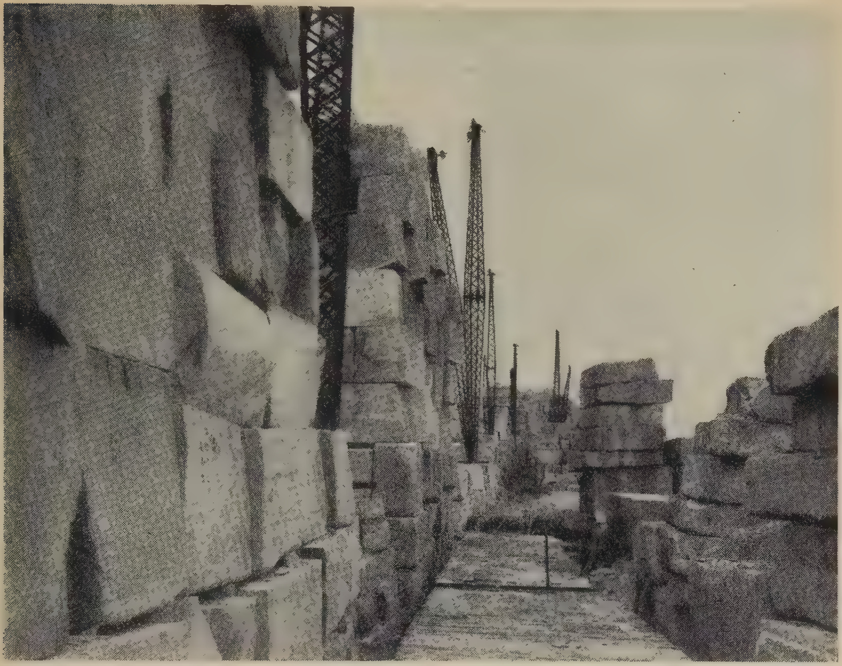


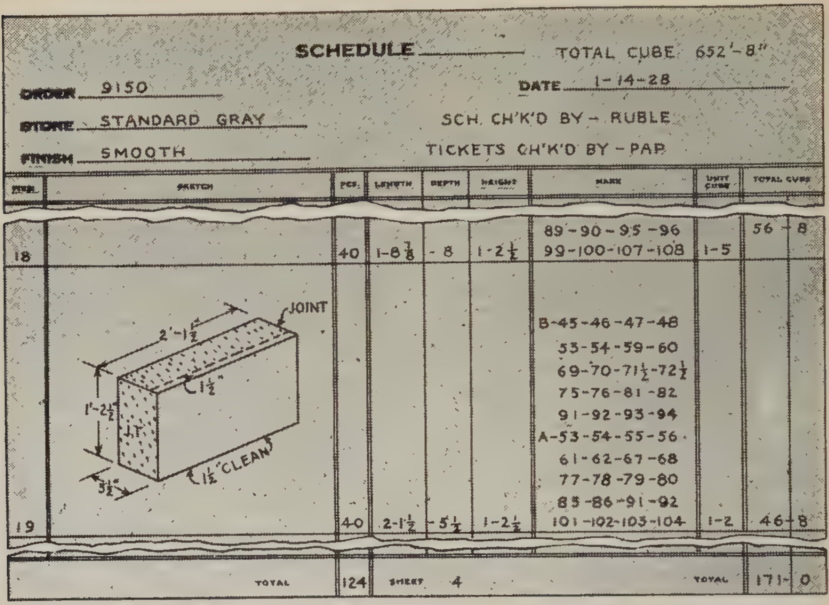
FIGURE 94. *Stock in the P. M. and B. quarry. Handling this heavy material complicates the inventory control problem*

that his department came clean. If there was need for special pressure to meet a difficult situation, the manager put it up to the foremen, the foremen put it up to the men, and everybody, knowing the importance of the job, put forth his best efforts to get it through on time. Control was personal, rather than clerical.

We did not feel that there was any special advantage in a radical disturbance of a plan of control which was working well. We planned the new system of control, therefore, so as to continue to put it up to the workman to get results.

The stone-cutting mills buy from the quarries like any other customer, being charged a price per cubic foot based on production cost and grade. The mills must show their profit on the use of this material just as if they bought it from an outside supplier. Since every piece of stone is produced to customer's order, production is a special-order proposition.

When an order is received, usually from a building contractor,



SCHEDULE TOTAL CUBE 652'-8"

ORDER 9150

DATE 1-14-28

STONE STANDARD GRAY

SCH. CH'K'D BY - RUBLE

FINISH SMOOTH

TICKETS CH'K'D BY - PAP

[illegible]	SKETCH	PCS.	LENGTH	DEPTH	HEIGHT	MARK	UNIT CUBE	TOTAL CUBE	
18		40	1-8⅞	-8	1-2½	89-90-95-96 99-100-107-108	1-5	56	8
19		40	2-1½	-5½	1-2½	B-45-46-47-48 53-54-59-60 69-70-71½-72½ 75-76-81-82 91-92-93-94 A-53-54-55-56 61-62-67-68 77-78-79-80 85-86-91-92 101-102-103-104	1-2	46	8
	TOTAL	124	SHEET 4				TOTAL	171	0

FIGURE 95. *This job schedule, of which only one item is shown, lists all pieces on an order. Job tickets (below) are duplicated from it*

we get the architect's drawings, which presumably, although not always, show all details of stone work. From these drawings our drafting department prepares stone drawings, showing every stone in the wall, or other construction. After these drawings have been approved by the architect, schedules are made of the stone required on the job (Figure 95) and a work order with drawing is prepared on a duplicating machine, one for each stone (Figure 96).

Production control, clearly, involves the control of an almost infinite amount of detail. We control this detail by dividing it among many men, and bringing each of these men into as direct contact with the customer's necessities as possible.

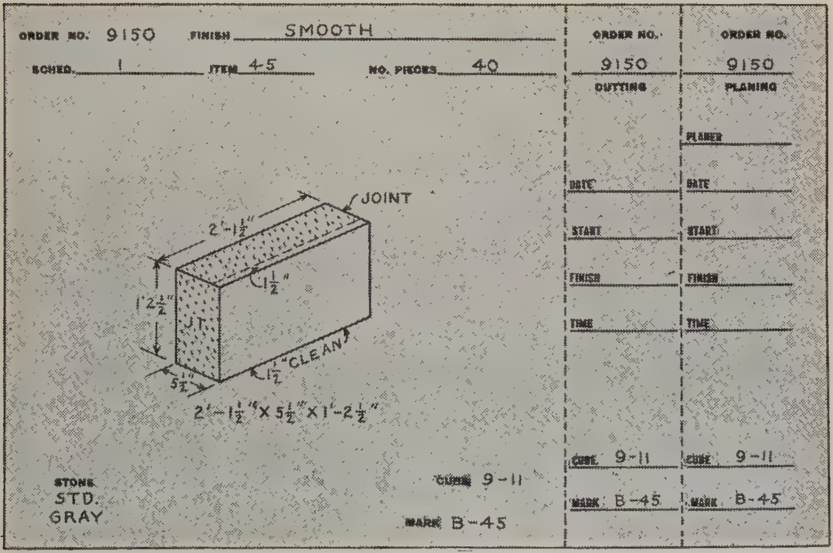
The cut stone department heads up, like the quarries, in a vice-president in charge of production. Reporting to him are two assistant vice-presidents, one a contact man between customer and mill, the other in immediate charge of operations.

Under the vice-president in charge of cut stone production are 24 mills, divided into four groups of six each. Each group is operated as a unit, in charge of a group manager, who has an assistant and the necessary clerical help.

All orders are received by the production department, which decides by which group of mills the order should be handled. The decision is made in view of the work ahead of each group, the special facilities and experience of this or that mill, nearness to the quarries from which the stone is to come, a fair distribution of easy and slow work, and like considerations.

When an order is assigned to a group manager it becomes his responsibility from that time on. Each group operates its own drafting department and prepares the drawings and bills of material already mentioned. When these drawings have been approved, the order is ready to put into work.

The operations of finishing the cut stone are much like those of a machine shop. The first operation is usually sawing, first into flat slabs and then usually at right angles, giving rectangular stone blocks of the required dimensions. These pieces are then planed, or turned on the lathe or boring mill, or otherwise worked to the required profile, a zinc pattern of which accompanies the job. Various other operations may be required. Finally the block is


ORDER NO. 9150 FINISH SMOOTH

SCHED. 1 ITEM 4-5 NO. PIECES 40

STONE STD. GRAY

CUBE 9-11

MARK B-45

ORDER NO. 9150

CUTTING

DATE

START

FINISH

TIME

CUBE 9-11

MARK B-45

ORDER NO. 9150

PLANING

PLANER

DATE

START

FINISH

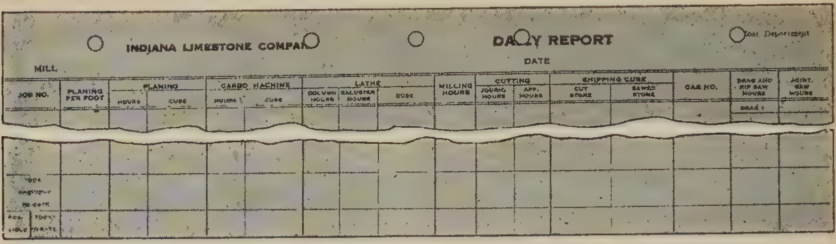
TIME

CUBE 9-11

MARK B-45

JOINT
2'-1½"
1½"
1'2½"
JT.
5½"
1½" CLEAN
2'-1½"×5½"×1'-2½"

FIGURE 96. *A job ticket is made for each piece. Stubs are detached as the job progresses, and sent for use in checking progress and making cost and time cards*



INDIANA LIMESTONE COMPA DA Y REPORT Cost Department

MILL

DATE

JOB NO.	PLANING PER FOOT	PLANING		CARBO. MACHINE		LATHE			MILLING HOURS	CUTTING		SHIPPING CUBE		CAR NO.	DRAG AND RIP SAW HOURS	JOINT. SAW HOURS
		HOURS	CUBE	HOURS	CUBE	COLUMN HOURS	BALUSTER HOURS	CUBE		JOURN. HOURS	APP. HOURS	CUT STONE	SAWED STONE		DRAG 1	

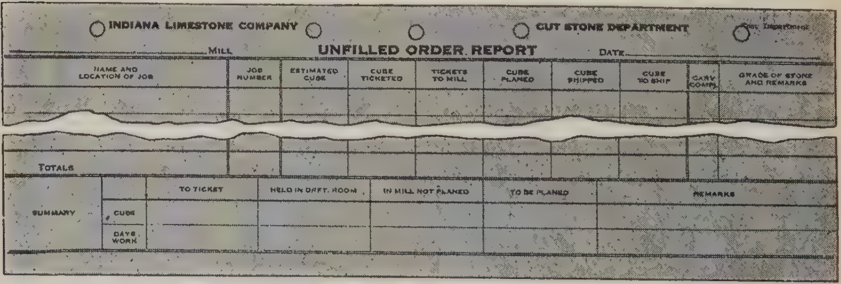
FIGURE 97. *This weekly summary shows the position of the mills as a whole. Estimated production is checked against "cube ticketed" output*

checked with the drawing and packed in cars with other pieces on the job.

Coming next to the control of these processes, the group manager decides which mill is equipped to turn out the order. He instructs the mill superintendent as to the promised dates and urgency of the order, and turns the material lists, master drawings and individual production orders over to the superintendent.

The superintendent must now plan the actual production. In conference with the group manager, he decides which orders must be filled next week, and makes out a weekly schedule (Figure 97) which constitutes the plan of work and the promise of delivery for his department. If a salesman, or the assistant vice-president in charge of contract relations, wants to get a rush job through for the customer, he must see to it that it gets into next week's schedule, for it is our policy not to disturb a schedule once it is made.

The stone drawings on a big job call for many carloads of stone. These stones, each of which carries a job number, are grouped in



INDIANA LIMESTONE COMPANY CUT STONE DEPARTMENT Cost Department

MILL UNFILLED ORDER REPORT DATE

NAME AND LOCATION OF JOB	JOB NUMBER	ESTIMATED CUBE	CUBE TICKETED	TICKETS TO MILL	CUBE PLANED	CUBE SHIPPED	CUBE TO SHIP	CARV. COMP.	GRADE OF STONE AND REMARKS
TOTALS									

		TO TICKET	HELD IN DRFT. ROOM	IN MILL NOT PLANED	TO BE PLANED	REMARKS
SUMMARY	CUBE					
	DAYS WORK					

FIGURE 98. *A close check can be kept on the efficiency of every mill through this detailed daily report of work done by each department of each mill*

order by the courses in which they will be laid in the building, numbered from the bottom up. The stones and courses are further grouped by carloads, so that the job of the superintendent is simply to get out the blocks in serial order from the bottom up, seeing to it that each carload is ready for shipment by the scheduled date. Thus the apparently complicated control becomes comparatively simple.

After he had made out his schedules, the superintendent gets the job into work. He selects from stock the quarried blocks from which each lot of pieces may be cut to best advantage. He then gives the proper bill of material (of which there are many on a large contract) to the stone sawyer, together with the individual job tickets.

As soon as the individual piece has been separated from the block, the corresponding job ticket is attached to it and travels with the piece from that point on to shipment. These tickets, as shown in Figure 96, carry two detachable stubs. One of these stubs is detached by the planer foreman as soon as his operation is finished and is sent to the shop clerk, with starting and stopping time entered. A second stub reaches the shop clerk on completion of the cutting or carving operations, and the ticket itself is taken from the piece and returned when the piece is in the car, loaded after final inspection. From these tickets the time and cost records and the progress reports are made up.

A very simple progress record enables the superintendent to know hour by hour just how far any job has progressed. As the first stub comes in, a check is made with a red pencil on the block as shown on the stone drawing. When the final ticket is received a circle is made on the block with a black pencil. If any piece fails to show up as finally inspected and packed, the fact is evident from a glance at the stone drawings.

The superintendent is also responsible for the costs of his mill. Too heavy a stock of quarried blocks affects his costs unfavorably. If he has a good record for delivery or breakages and delays, it will count in his favor in the comparative showing between mills.

Breakages and rush replacement orders from the customer, by the way, are put through like any other order, but on a green ticket which everybody knows carries precedence over any other job.

Having disposed of the mass of detail by dividing it, the next question is that of liaison and control. The need for this control obviously starts in the drafting department, whose work may take months on a big job. So this department works to weekly schedule like any other. It also makes out a detailed daily report on job progress. A few representative excerpts from one of these daily reports are shown in Figure 99.

In the mills, our control is simple but is kept up to the minute. The shop clerk prepares a daily report (Figure 98) showing the production in cubic feet or by number of pieces, for each of the various operating departments. This is in the nature of a cost and production control, and carries a comparison of actual with possible or scheduled production.

From Paul A. Huff, Chief Draftsman, Group No. 1.
To John MacMillan, Production Manager, Cut Stone Department.
Condition of Work in Drafting Room as of Friday, July 12th, 1929.

Order 9166—Hospital Group.
Working on drawings and schedules. Cube in mill 28,987 feet. Pavilion and Nurses Dormitory complete. Hospital in mill to approximately second floor. Pushing contractor to take stone. Are ahead of job.

Order 9184—High School.
Working on drawings and schedules. Have enough details now to make better progress.

Order 1002—Bank.
Drawings made and approved to 14th floor. Scheduling on these now. Men in Chicago working between 14th and 18th floors. Expect to place some work in mill about 23rd or 24th. Keeping after contractor for needed information.

FIGURE 99. *This informal typewritten report, made daily, shows drafting room progress on each job and lists causes of delay, if any*

A weekly report is also made by the plant superintendent showing accomplishment checked against the schedule, which, summarized for the various mills, constitutes an adequate progress record, both by total production and by individual order.

From these reports in turn a compact weekly summary of the production of all mills is drawn off for the guidance of the vice-president in charge of the department.

These records are all built out of the original individual mill re-

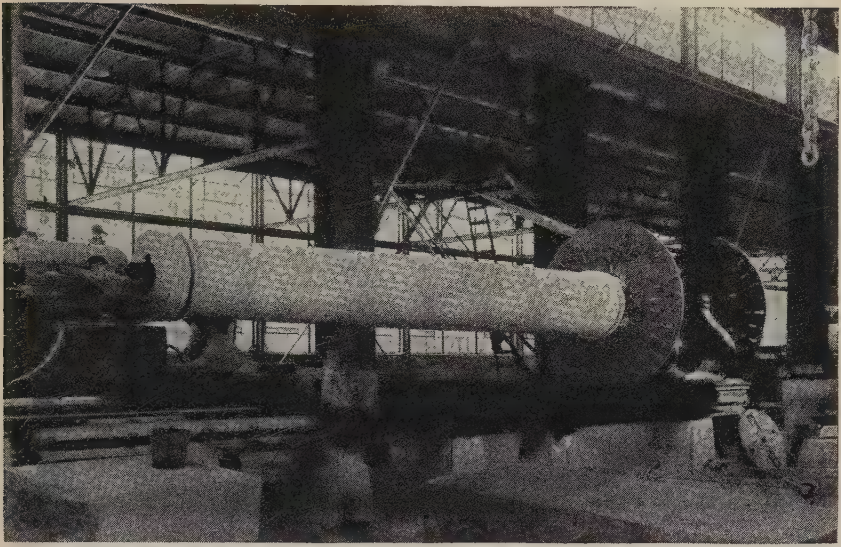


FIGURE 100. *A big monolithic column in the gun lathe. Superficially as wide apart as the poles, the stone-cutting shops operate on much the same plan as a job machine shop*

ports by simple totaling, which is made upon an adding machine, as, indeed, are the original mill reports very largely. Identical information goes to all interested parties, so that there is no conflict of understandings. The reports are for the most part so compact that many of the men habitually carry the current reports in which they are interested around with them in a pocket notebook.

If I were to summarize the philosophy which lies back of our plan of control I should emphasize the following points:

1. We localize detail.

2. We compare units. Each mill, and each group of six mills, is endeavoring to meet the standard set by the best of all the other units. This competition welds the personnel of each mill into a compact, loyal team, keen to see that their superintendent does not suffer by comparison with any other.

3. We do not interfere with the men. To do so upsets them, increases costs and in the long run delays production.

4. We keep our control records simple and see that every responsible man gets the facts he needs.

50% CUT IN PRODUCTION CONTROL COSTS

By F. J. KUNZE

Manager of Production Control, The American Multigraph Company

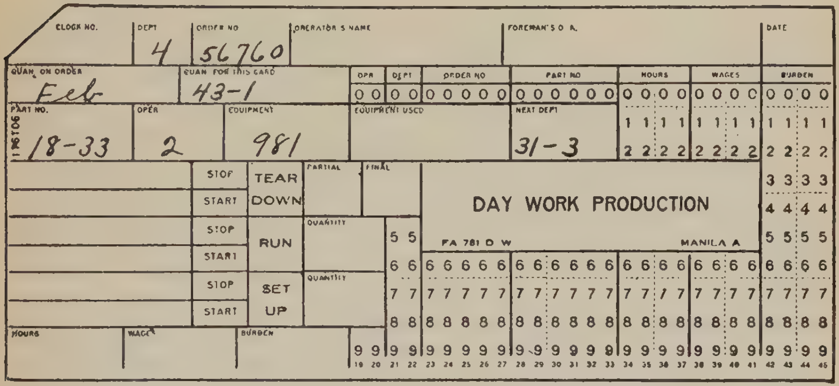
WHERE formerly we used 16 people to handle all planning, scheduling and production-control work as well as all raw and finished stores records in the American Multigraph Company, we now require but seven. A pneumatic tube system and centralized control of all operations not only have reduced overhead but have released the space in manufacturing departments formerly needed for schedule clerks. The number of forms has likewise been reduced. Even better than this, is the stable maintenance of satisfactory inventories and prompt service to our branches. Better control has made possible a reduction in inventories of raw, semi-finished and finished stocks without interfering with improved service to sales force and customers.

Because sales and inventory records are indispensable to planning, at the beginning of each month we receive in the production-control department a detailed summary, listing the previous month's sales of all models and parts at each of the 55 domestic branches, foreign divisions, and agencies, and covering all machines and parts in stock at these several points. This information, consolidated, is transferred to a sales and production schedule form, which provides space for a 3-year record. Thus, in figuring the number of parts and machines to be manufactured we take into account the average monthly sales over the past four months, as well as the total branch inventory, including demonstrating machines, attachments, and service parts. We must consider, in addition, the length of time required to deliver machines and attachments to these various branches so that normal inventories may be maintained at all times.

To cover seasonal fluctuations in sales, we have developed a chart showing the average of total sales each month over the past 12 years. This gives us a fairly accurate month-by-month trend so that we know definitely, for example, that July and August are the low sales months in the year, whereas the volume jumps rapidly in September and October. Because of the nature of the raw materials and the semi-finished products used, we must schedule our manufacturing approximately five months in advance and hence must watch these seasonal rises and falls carefully.

Before these actual figures are made the basis for setting up manufacturing schedules, the views of sales executives and the reports of the research department are taken into account. Special market conditions or the development of new equipment may, of course, lead to changes in the proposed production plans.

As soon as the manufacturing schedule is set up for a month's production, it is sent to the planning division. From this detailed schedule the planning division ascertains the number of parts to be fabricated or withdrawn from factory inventories for sub- and final assembly, as well as the quantities of raw materials to be purchased.



CLOCK NO.

DEPT 4

ORDER NO 56760

OPERATOR'S NAME

FOREMAN'S O. K.

DATE

QUAN. ON ORDER Feb

QUAN. FOR THIS CARD 43-1

PART NO. 18-33

OPER 2

EQUIPMENT 981

EQUIPMENT USED

NEXT DEPT 31-3

STOP / START — TEAR DOWN

STOP / START — RUN

STOP / START — SET UP

PARTIAL

FINAL

QUANTITY

QUANTITY

HOURS

WAGES

BURDEN

DAY WORK PRODUCTION

FA 781 D W

MANILA A

OPR
DEPT
ORDER NO
PART NO
HOURS
WAGES
BURDEN
0 1 2 3 4 5 6 7 8 9
19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45

Figure 101. *Tabulating machine cards collect labor and material costs*

The first move in accomplishing this is to write up an assembly order in duplicate—the original on paper, the duplicate on a card—for each lot of machines to be assembled. At the same time a bill of materials covering parts is prepared in duplicate.

The planning division next checks against the stock inventory record the bill of materials requisitioning parts, to see if sufficient parts are available for the final assembly, or if additional parts must be manufactured. Reference here is made to an inventory control card, an individual inventory card being carried for each unit, whether it be a complete assembly, sub-assembly or single part. The inventory card lists the actual stocks on hand in finished stock, the total of parts applied against bills of materials already approved and waiting for final assembly, and in another section the number of parts in process, thus giving a complete history of all the parts in the plant. If this finished stock record shows that an insufficient number of this particular part is available, a manufacturing order is at once made out to cover the number of parts required to complete the order and to maintain sufficient inventory in reserve in the stock room.

Before such a manufacturing order is written, it is definitely determined whether additional parts of this kind are needed for service. If so, the additional number required of each kind is added to the number necessary to fill the original manufacturing order. This plan eliminates the waste of time and money involved in sending through special orders or small lots of parts for service purposes.

For the manufacturing of such sub-assembly parts an assembly order, like the one used for the original order of machines, is also prepared, and in the same manner this sub-assembly bill of materials is checked against the proper inventory cards to see whether any single parts must be made to fill the sub-assembly requirements of that order. If any, or all, of these parts must be fabricated, the number in each lot to be manufactured is determined by the size of the lot order of sub-assemblies as well as by the status of service-part inventories. Thus when single parts are to be manufactured, the same procedure is followed in preparing a production order as in the cases of the original lot and sub-assembly orders.

All of these forms are exactly the same as those used in writing up the first lot order. The possibility of using these forms for final assembly, sub-assembly, and single part orders, shows how practical they are.

As scheduling and planning must be followed by standard performance practices, a general information card for each assembly, each sub-assembly and each single part is carried in the planning division files. In the case of any sub-assembly part the information card, for example, lists all single parts which go into this particular sub-assembly; the number of times each single part is used; the operations that are to be performed to make the completed sub-assembly; the department or departments in which this assembly is made; the kind of equipment used in making the assembly; and the amount of standard time necessary for each operation.

From this general information card the manufacturing order is written for each lot of single parts necessary for the sub-assembly. This order shows the part symbol, number of pieces to be made, operation numbers, manufacturing departments, equipment to be used, and unit time for each operation, as well as the cumulative hours necessary to complete the lot order. The manufacturing order then goes to the raw materials stock clerk to determine whether sufficient raw materials are in stock, or whether they should be ordered. If they must be bought, the requisition is written and checked by the head of the planning division, and sent to the purchasing department for action.

The planning division likewise prepares all time cards covering the operations necessary in the manufacturing process. A time card of one color is used for set-up and tear-down operations, and another color for piece-work. These time cards are placed with the manufacturing order in a metal container, and filed according to date when the manufacturing operations are scheduled to begin. This file of manufacturing orders is also used as a tickler for checking the receipt of purchased raw materials so that supplies may be on hand for starting of production of parts on schedule time.

When the raw materials arrive in the stock room, the receiving slip, properly receipted, is sent to the raw materials inventory clerk in the planning division who, in turn, records the entry of the material in raw stores on the inventory card. At the time set for starting manufacturing activity on the single parts, this clerk takes the original and duplicate manufacturing orders, the time cards covering all operations in the order, and the requisitions for raw materials to the schedule division.

SCHEDULING AND CONTROL OF PRODUCTION

When the metal folder containing the manufacturing orders, time cards and requisition is in the scheduling division the order is immediately checked against the time cards to see that operations and numbering are accurate. Each time card (see Figure 101) shows the order number, part number, operation to be performed, department doing work, equipment to be used, department and equipment where the next operation is to be performed, etc.

Next, the duplicate manufacturing order is removed from the metal folder and placed upon a visible traffic production board, according to the calendar month in which the finished parts are needed.

The time cards are taken to a long production-schedule desk nearby. This is divided into sections, each representing a manufacturing department. Each departmental division is, in fact, a file tray divided into two major sections. In the fore part of this file are the time cards covering operations on materials which have already been received in that particular department. This section again is subdivided according to the numbering of the machines in the department, and here the time cards are placed against specific equipment. The back half of the file contains the cards covering future production, for which materials have not already been received in that department. Hence the schedule clerk segregates, according to departments, in the rear division of the file trays, the lot of time cards just received.

With the manufacturing order now on the traffic board and with the time cards segregated according to production departments, we are ready for production activity on this lot order.

The original manufacturing order and requisition for raw materials is sent to the stock room, whence the manufacturing order accompanies the raw materials to the department where production is to begin. The raw stores operator at the same time signs the requisition and sends it to the scheduling department by pneumatic tube. This shows the schedule clerk that the materials are at the proper station ready for fabrication.

The schedule clerk then pulls the first time cards covering set-up and piece production from the file of the department where operations began, and makes out a notice for tools, listing part number, operation number and department. The tool notice and time cards, attached by clip, go by pneumatic tube to the manufacturing department.

Where the service of a product depends upon the interchangeability of parts and precision is maintained, precautions are necessary against delays in manufacturing. It takes about one minute to transfer information from a production department to the schedule division and return through the pneumatic tube system. Delay in some instances could be tolerated, in case a manufacturing performance is stopped. But when one considers that at least 80 per cent of our operations are performed with special dies, tools, gages, or fixtures, which are held in departmental tool cribs, it is readily seen that the preparation to perform most operations consumes more time than we could afford to lose if it is necessary to stop an operation.

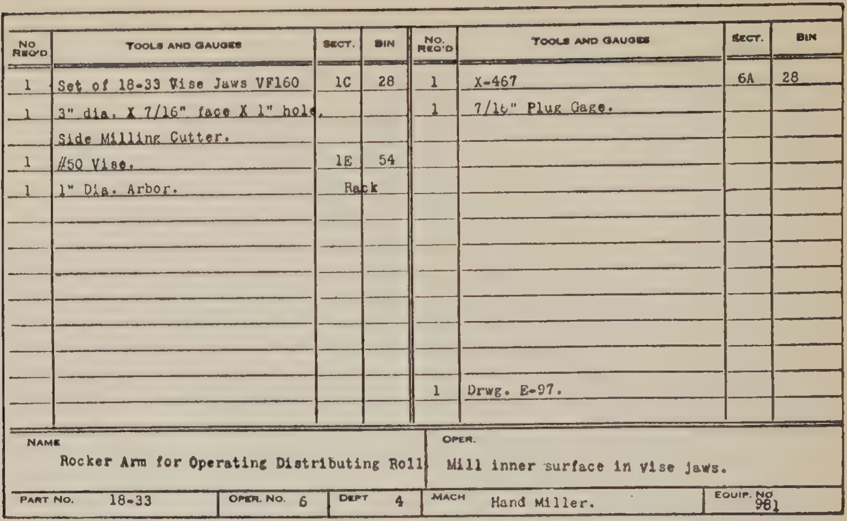
In each manufacturing department a planning board has helped to eliminate factory clerks. This planning board is in three sections: Part one carries cards covering operations in process. The second section holds time cards for the workmen's next operations, for which the tool notice has already been delivered to the tool crib and the tools are being assembled. The third section contains time cards which are regarded as alternatives, if for any reason the operations in process or scheduled in the second board are halted. Otherwise these cards are moved up to the second and then to the first board in regular procedure, as operations are completed.

The foreman at the proper time sends the tool requisition to the departmental tool crib. Here the tools are immediately assembled and turned over to a worker for setting up. Accompanying the tools is a manufacturing information card, Figure 102, enclosed in a waxed-paper envelope. One side of this card lists all tools necessary for that particular operation and the place where they are to be found in the tool crib. The reverse side gives in chronological order instructions as to how the tools are to be used, the speed and feeds, how gaged and set, and the time necessary for performing this manufacturing operation.

Upon the completion of the operation, the time cards, properly filled in and checked by the foreman, are sent by tube to the production-control division. A schedule clerk scratches off that particular operation on the manufacturing order, which is filed on the visible traffic production board. The time card for the next operation on the lot is pulled from the back of the respective departmental tray, and placed in the fore section, which, as explained, is divided as to machine equipment.

If there be other cards in that section, indicating that materials are already at that particular equipment awaiting fabrication, the schedule clerk must determine which of the orders should have first attention. An examination of the time cards determines this. The order calling for earliest delivery takes precedence. If several time cards call for final assembly at the same time, then the schedule clerk sends to the department a card covering the lot which requires a longer time for production. After determining this, the time cards, with the tool-crib requisition, go by tube to the manufacturing department. This same procedure, of course, is repeated on each operation until the lot is sent to the finished stores for final assembly.

This schedule plan may not sound simple, but we have found in the manufacture of our products, which call for some 4,500 different parts, that three people can handle and control these production



NO REQ'D	TOOLS AND GAUGES	SECT.	BIN	NO. REQ'D	TOOLS AND GAUGES	SECT.	BIN
1	Set of 18-33 Vise Jaws VF160	1C	28	1	X-467	6A	28
1	3" dia. X 7/16" face X 1" hole,			1	7/16" Plug Gage.		
	Side Milling Cutter.						
1	#50 Vise.	1E	54				
1	1" Dia. Arbor.	Rack					
				1	Drwg. E-97.		

NAME Rocker Arm for Operating Distributing Roll

OPER. Mill inner surface in vise jaws.

PART NO. 18-33 | OPER. NO. 6 | DEPT 4 | MACH Hand Miller. | EQUIP. NO 981

FIGURE 102. *A tool list accompanies each order for a part. On the reverse side is an instruction card*

orders. Furthermore, within a half hour the status of any order, or the work ahead of any department or individual machine can be ascertained.

In the production department, a cost clerk checks each card and enters upon a cost control card the exact production time for the operation. These cost cards supply accurate data for time study and for the analysis of production costs, revealing whether or not any department or any workman is producing according to standards. Thus the time cards serve a three-fold purpose: Time record, scheduling production, and cost checking.

300 PER CENT GREATER PRODUCTION WITH 65 PER CENT LESS INVENTORY

BY W. C. BEATTIE

Assistant Director of Production and Stores, Westinghouse Electric and Manufacturing Company, Mansfield Plant

THE planning board used for production control in the punch press department of the Westinghouse plant has three pockets for each press: load pocket, in which are filed all work tickets for the month; in-work pocket, in which are filed all work tickets as the material becomes available for each press; delay pocket, in which are filed all work tickets for jobs delayed.

Up to this point the orders to the department have been taken from the chart, written up on master work sheets, then on work tickets, and appear in the planning board in the "load" pocket. The production man carefully reviews the load for each press and arranges the work tickets in the load pockets in their order as delivery is required. Requisitions for the raw material are attached to the work ticket for the first operation. As the work tickets are taken from the board, the requisitions for all raw material, except that to be sheared, are sent to the storeroom.

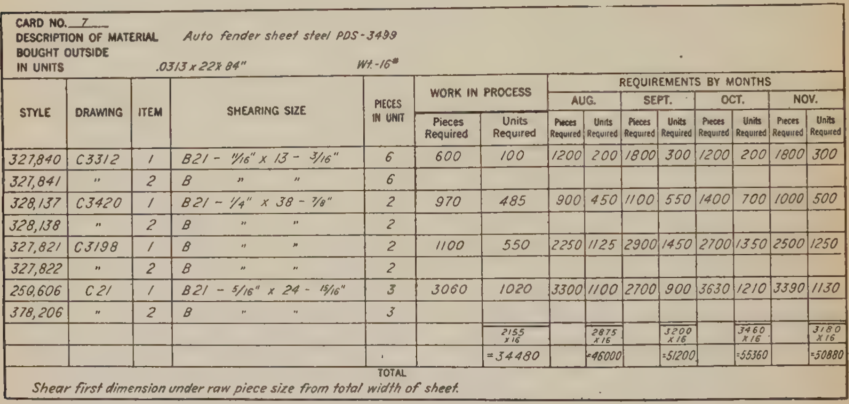
Work tickets for parts which must be sheared before the first punch press operation are sent to the shear room daily, one week in advance of the time the first operation must be performed. A small planning board is used in the shear room, having seven pockets, one for each day. The work tickets are filed in advance for each day in the order in which the jobs for that day are to be sheared. As the shear room foreman requires raw material he detaches the requisition and hands it to the stockman, who delivers the material direct to the shears.

As soon as the job is sheared, the work ticket is returned to the production office. The date and quantity sheared are entered on the master work sheet, and the job ticket for the first operation advanced from the load pocket to the in-work pocket of the planning board, for the punch press to perform the first operation.

The foreman over each group of presses has a blackboard visible from the production office. As a job nears completion he presses a button ringing a bell to attract the production man's attention, and writes on his blackboard the press number that will be out of work. The production man selects the next job to be run in that press from the in-work pocket, tears the work ticket apart, and sends the original with the drawing for the part to the die storage room, by means of a chute provided for that purpose. The carbon copy of the work ticket left in the in-work pocket indicates the job that is actually in work.

The die storage man delivers the die, drawing, and job ticket to the press, taking the die just removed from the press back to die storage on his return trip. While the die is being set, the foreman has the material to be used moved to the press and arranged for most efficient handling by the press operator. After the die is set, the die-setter has the first piece run checked by an inspector and reports to the foreman, who assigns an operator.

When the job is completed the die-setter notes the quantity run and the operator's name and clock number on the job ticket, and it is returned to the production office. Quantity run is recorded on the master work sheet, and the carbon copy of work ticket removed from the planning board and destroyed. The work ticket for the next operation is then advanced to the in-work pocket. The original copy of the work ticket for the operation just completed is handed to the department time clerk and entered on the operator's efficiency record.



CARD NO. 7
DESCRIPTION OF MATERIAL Auto fender sheet steel PDS-3499
BOUGHT OUTSIDE
IN UNITS .0313 x 22⅞ 84" Wt.-16#

STYLE	DRAWING	ITEM	SHEARING SIZE	PIECES IN UNIT	WORK IN PROCESS		REQUIREMENTS BY MONTHS							
							AUG.		SEPT.		OCT.		NOV.	
					Pieces Required	Units Required	Pieces Required	Units Required	Pieces Required	Units Required	Pieces Required	Units Required	Pieces Required	Units Required
327,840	C3312	1	B21 - 11/16" x 13 - 3/16"	6	600	100	1200	200	1800	300	1200	200	1800	300
327,841	"	2	B " "	6										
328,137	C3420	1	B21 - 1/4" x 38 - 7/8"	2	970	485	900	450	1100	550	1400	700	1000	500
328,138	"	2	B " "	2										
327,821	C3198	1	B " "	2	1100	550	2250	1125	2900	1450	2700	1350	2500	1250
327,822	"	2	B " "	2										
250,606	C21	1	B21 - 5/16" x 24 - 15/16"	3	3060	1020	3300	1100	2700	900	3630	1210	3390	1130
378,206	"	2	B " "	3										
						2155 x 16		2875 x 16		3200 x 16		3460 x 16		3180 x 16
						= 34480		=46000		=51200		=55360		=50880

TOTAL
Shear first dimension under raw piece size from total width of sheet.

FIGURE 103. *A card index system is used to regulate the inventory of materials*

If a die breaks down, a blue card is fastened to the new work ticket indicating that the die is down and the work ticket is filed in the delay pocket in the planning board. A red card is used for machine tool breakdowns and a yellow card for material delays. These colored cards are in full view of foreman and production men as a constant reminder of jobs delayed.

All jobs completed are checked and counted by inspectors who write deliveries to the next department, or stores. These deliveries are written in duplicate, the original accompanying the material and the copy going to the production office.

The charts are marked up at the time the master work sheets and job tickets are written, and when material is sheared and delivery started.

The control of all purchased parts and raw material is included in the duties of the central production office force, who determine requirements and provide charts for follow-up in the same manner as for manufactured parts. It is necessary that we work out the required material quantities for each part in detail, since we found that providing supplies through average requirements, or minimum and maximum availables, was not positive enough where rapid changes and turnover are required.

The raw material required for each part is shown on a card index (Figure 103). There is a different card for each item of raw material we use. All parts made from each material are listed on the corresponding card, which bears a reference number that is shown on all records for each component part using this material.

Advance schedules of parts covering four months in advance are posted monthly to the cards from the manufacturing information (Figure 103). The pieces required for each month are then divided by the pieces per purchasing unit, and the number of units totaled by months and multiplied by the weight or measure of one unit.

The number of pieces available in fabricated parts in stock and in process are posted to cards and shown as available against material, in the same manner that requirements are figured. Requirements by months, fabricated parts available, stores stock, and open orders are then posted on the back of each card. Then orders to suppliers and follow-up charts are written.

Our system has been built largely to permit of rapid changes in design and in quantity output with minimum confusion and losses. We could simplify procedure greatly if such changes were not imperative from time to time, usually without much warning.

TREMENDOUS COST REDUCTIONS

The ability to change monthly to the new month's load, without interrupting the work in any department while making the adjustments, is perhaps the most outstanding advantage secured. At the same time, raw material inventories have been cut 73 per cent and work-in-process inventories 57 per cent. That is, we have reduced our stocks of fabricated parts and raw materials 65 per cent, while increasing production 300 per cent.

Finished stock inventories have been radically reduced without in any way affecting deliveries to the sales department, but the percentage reduction due to production methods cannot be determined.

So many other factors, such as distribution and storage, have been changed at the same time. Purchasing and manufacturing costs have been reduced by scheduling according to the most economical quantities to buy or make, as indicated by set-up and handling costs as against carrying charges. The personnel of the production control and stores department has been reduced from 33 people to 25 under present methods.

Specific comparisons of benefits in making any one item would be misleading, because factors of cost, equipment, quality, etc., enter in. But the overall economies and advantages brought about have vastly aided the Mansfield plant in improving production control and reducing manufacturing costs.

CUTTING COSTS 20% AND MAKING 100% ON-TIME SHIPMENTS

By JOHN HEARTY
President, The Imperial Electric Company

THERE are two things which a customer wants above all. One is quality, the other service. The latter term does not imply making empty promises of something for nothing, giving an unwarranted amount of free advice and assistance, or going to a heavy expense merely to satisfy the exacting demands of an unreasonable buyer who drives a hard bargain.

But it does mean at least two or three very important things from the customer's standpoint—knowing how long it will take to fill an order, shipping that order exactly when promised, and furnishing repair parts promptly at all times. None of these requirements can be fulfilled without a well-organized and equipped plant, operating under a thorough system of production control. But such a system, adapted to local conditions, can be installed and operated on a money-saving basis in any plant, large or small.

The immediate occasion for developing a complete system of production control in the Imperial Electric Company five years ago was to maintain the good relations existing with customers, who were very particular about receiving shipments on orders when promised. A good customer would be right in putting up a vigorous "kick" at a long delayed shipment, and special diplomacy and considerable expense would be required to settle such matters and preserve goodwill. These occurrences, if often repeated, were fraught with so many dangerous possibilities in the way of loss of business that, then and there, the determination was made to correct any trouble right at the source. With the co-operation of the plant superintendent, production departments and purchasing and sales organizations, a new method was worked out. This method was to schedule all operations so that from the time a stock or a special order was received until the machines were ready to ship, every step would be planned for a definite date, and completion or shipping dates would positively be met.

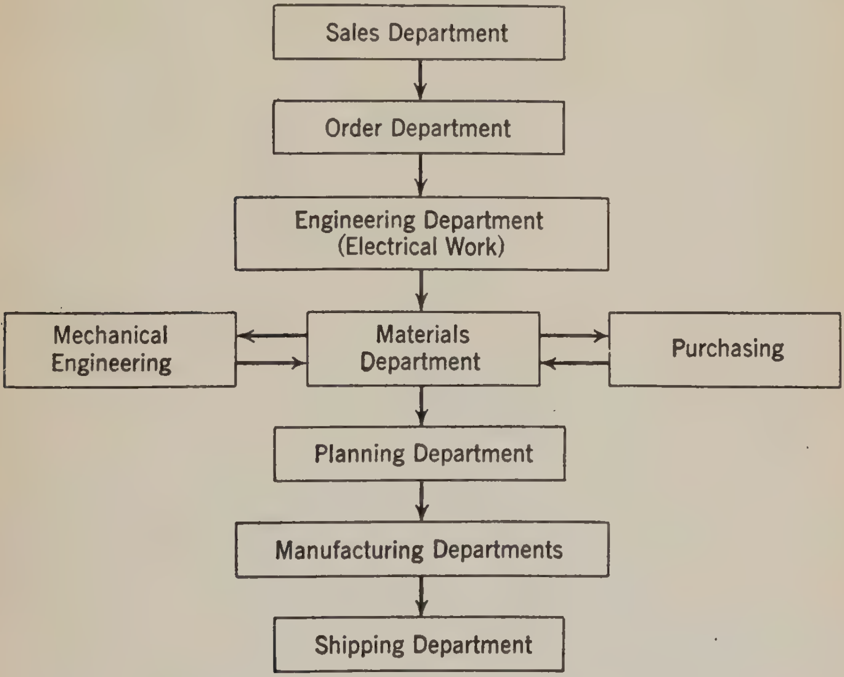

Sales Department
Order Department
Engineering Department (Electrical Work)
Mechanical Engineering
Materials Department
Purchasing
Planning Department
Manufacturing Departments
Shipping Department

FIGURE 104. *Route followed by manufacturing order*

The system thus worked out accomplishes two major purposes: (1) it follows up each order from sales department to shipping room; (2) it insures having sufficient parts on hand at all times for assembly into regular machines.

The company manufactures d. c. industrial motors and generators from ½ to 100 hp., a. c. machines from ½ to 200 hp. and motorgenerator set-ups to 100 kw. About 100 workers are employed in the factory and 35 in the office. Three of the latter operate the production control system and two the perpetual inventory records.

Certain types and sizes of motors are stocked. Production orders are put through for these, based on careful market researches conducted by the sales department for periods about six months ahead. Other types and sizes are made only upon receipt of special orders. Inventories of parts are co-ordinated with the production program, so that neither too much nor too little is carried. Special parts and equipment, particularly certain kinds of motor control apparatus, odd-sized pulleys, etc., are purchased only when needed on a special order. Close contact between production, sales and purchasing departments is, therefore, maintained to see that materials for both stock and special machines are on hand exactly when necessary, to fit into the pre-determined production schedule, without error or delay.

Figure 104 shows the route of a manufacturing order. Such an order on a preliminary form originates in the sales department, and

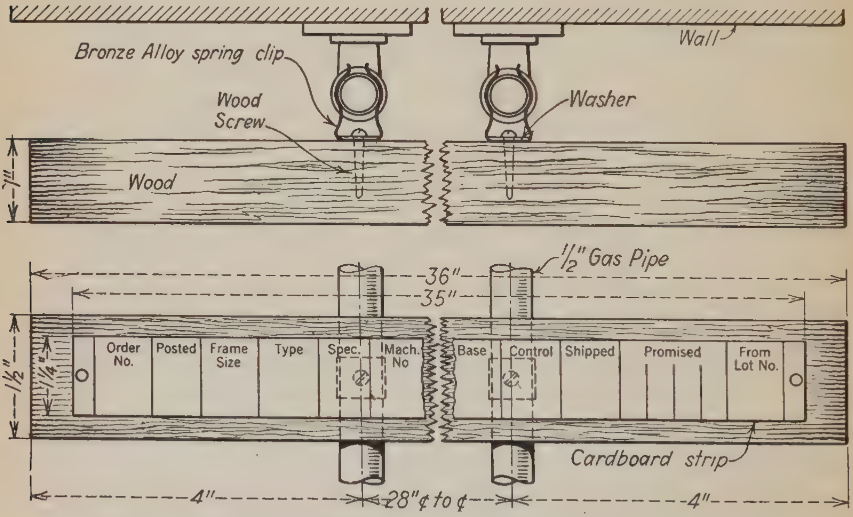

Wall
Bronze Alloy spring clip
Wood Screw
Washer
Wood
1"
1/2" Gas Pipe
36"
35"
1 1/2"
1 1/4"
Order No.
Posted
Frame Size
Type
Spec.
Mach. No
Base
Control
Shipped
Promised
From Lot No.
Cardboard strip
4"
28" ℄ to ℄
4"

FIGURE 105. *Production is controlled by a most flexible mechanism*
Cardboard strips, to carry the data as information is collected and recorded on the progress of each order, are mounted on sticks supported on pipe holders, which form "control boards." These sticks are moved from "board" to "board" as the orders go from each department to the next, and form a most ingenious physical mechanism for control.

calls for either stock machines or special machines. The sales department knows at all times the quantity of stock machines of all types and sizes on hand, as will be explained later. The order then goes to the order department where a stenographer types it, making ten copies, and prepares the production control slips, which are described below. Four copies of the order are sent to the engineering department and are inspected for correctness from the electrical engineering standpoint. All bills of material, drawings, or special specifications that may be required, are made up and approved.

The planning department has meanwhile received a copy of the order. This copy is sent to the mechanical manufacturing department clerk, together with a bill of material from the engineering department. Mechanical route cards are prepared for the rotor core, stator core, rotor, etc. A manufacturing schedule is made up for the order, to correspond with the daily preference-of-work schedule set by the electrical division of the planning department, which is in charge of the head of the department.

Stores requisitions for mechanical parts and materials are written by the mechanical department. These go to the balance-of-stores clerk for apportionment, and later are returned to him again, after being filled from stock, for reduction from the inventory. The balance-of-stores clerk writes purchase requisitions to replenish stores of materials as they fall to the pre-established minimums. The mechanical department issues orders to make up for stock the parts which are processed at the plant, when stocks on these items run low. This department also issues purchase requisitions for all mechanical parts which must be ordered from outside.

A cost card is written for each route card. Labor costs are entered on it from the time cards and material costs from the stores requisitions. After the cost card is finally checked with the route card, it is sent to the time-keeping and cost accounting department.

In the electrical division of the planning department the manufacturing order is routed to go through the four different shop departments—core, stator, upper and then lower stockroom. A five-part tag of specifications is prepared, of which four parts go to the above departments and the bottom is the requisition on stores. The four parts of the tag provide for work on armature, field, interpole and machine assembly. This tag goes to the balance-of-stores for apportioning before it is issued to the shop. After this recording work has been performed, the order is ready to issue to the shops.

The fundamental mechanism of the production control system is a device developed at the plant. It consists of sticks of soft wood 36 in. long and 1½ x 1 in. in section. (See Fig 105.) Four inches in from each end, on one of the 1½-in. sides, bronze alloy fuse clips are attached with screws. Sets of holders for these sticks each consisting of two parallel lines of ½-in. gas pipes at 28-in. centers extending vertically from floor to ceiling, are installed about 1 in.

Table 12

DATA ON PRODUCTION CONTROL STRIPS

STRIP A	STRIP B	STRIP C
Lot Number	Order Number	Lot Number
Posted	Posted	Posted
Frame Size	Frame Size	Group
No. of Machines	Type	Sequence
Start	Specifications	Frame Size
Intensive	No. of Machines	Number of Machines
Tailing	Armature Coil	1st Inventory
Should Finish	Stator Coil	Requisition
Delayed to	Field Coils	Passed
Finished	Interpole Coils	Ordered
No. of Machines Finished	Commutator	Required
The above are followed by a series of 20 columns containing numbers from 1 to 100, in groups of 5	Collector	Delayed
	Armature	Material Here
	Rotor	2nd Inventory
	Stator	Released
	Shaft	Start
	Date to go in Oven	Intensive
	Date went in Oven	Tailing
	Date went in Stock	Should Finish
	Special Parts	Delayed to
	H.P.	Finished
	Speed	Frames
	Volts	Commutator Bonnet
	Phase	Pulley Bonnet
	Cycle	Bearings
	Bonnet Assembly	Commutator Bonnets Ball Bearing
	R-A Assembly	Pulley Bonnets Ball Bearing
	B-H Assembly	Ball Bearings
	Brushes	Shafts
	Erected	Arm Spider
	Length of Test	Commutator or Collector
	Tested	Spider
	Pulley	Rocker Arms
	Base	Main Poles
	Control	Interpoles
	Promised	Terminals
	From Lot Number	Bases

out along the wall of the room. The sticks are mounted, one above the other on these pipes by means of the clips. They can be taken off and transferred to another location merely by springing the clips. Within a 6-ft. range of access and visibility, about 45 of these sticks can be mounted on each of the sets of pipe holders.

Each stick carries a printed cardboard strip 35 in. long and 1¼ in. wide, fastened on it by thumb tacks. This strip carries the production schedule record. It has vertical spaces across it, printed with one of the three sets of notations given in Table 12, according to particular use.

The sales department also has a control board constructed just like those above described. Strips carrying the data in column A of Table 12 are employed on this board. Each strip signifies a certain lot of one definite type and size of machine which is being manufactured on a stock order. The blanks along the left end of the strip are filled in with the required data as manufacturing progresses, from the time the order is issued until it is completed.

Alongside of the series of numbers, 1 to 100 on these latter strips, are spaces for marking the number of machines completed by the factory, as each portion of a lot comes through. Thus, 10 machines may be finished on May 5, 15 more, or a total of 25, on May 12, 12 more, or a total of 37, on May 20, etc. As sales orders for these machines are received, the sales department puts a ring around the cumulative numbers on the strips, to indicate the total quantity actually sold. When this total sold crowds close to the number finished, the factory is warned to put pressure behind the production so that stocks will not run out. When sales approach 100, leaving a so-called "dead-line" balance of finished machines on hand, varying with the type and size of machine, a new manufacturing order is issued in sufficient time to get the next lot of machines completed before the first lot is sold. The new order calls for a quantity based upon current and prospective rates of sales.

Records of orders for special generators and motors, maintained on the sales department control board, are best described by outlining the procedure in the production control department for these orders. The sales records are an abridgment of the latter.

Strips carrying the data in column B of Table 12 are used in the production control department, to regulate the work on both stock and special orders throughout the plant. These strips are thumbtacked on the standard sticks. One vertical section of the pipe holders is assigned to each of the departments, or groups, shown in Figure 106.

ROUTING OF ORDER STRIPS

New order strips, coming from the order department, are mounted on sticks which are placed on the vertical row marked "Order." As

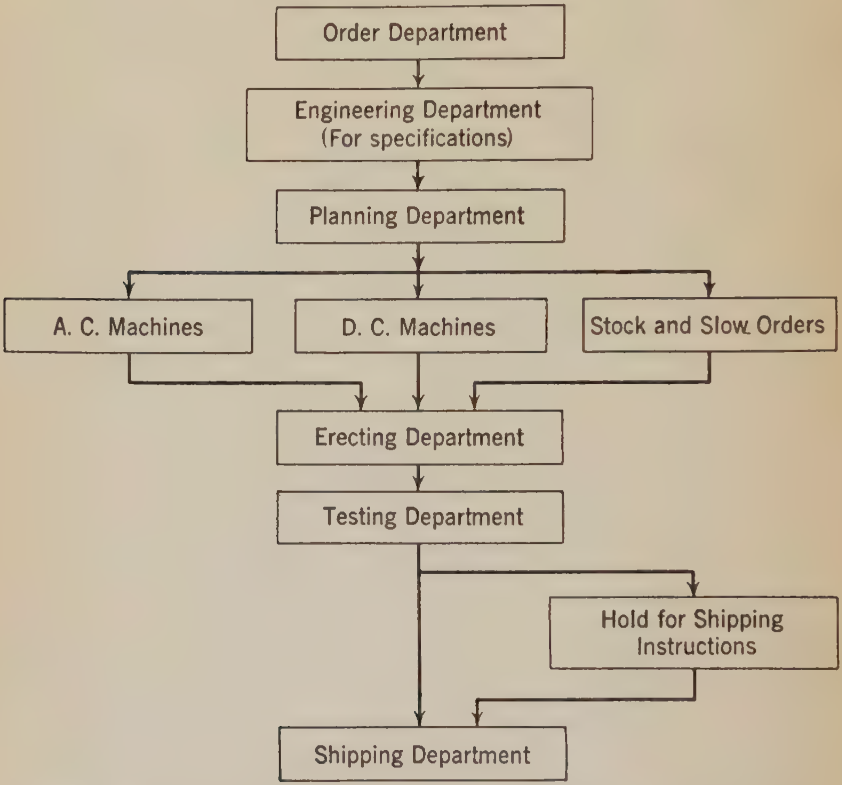

Order Department
Engineering Department (For specifications)
Planning Department
A. C. Machines
D. C. Machines
Stock and Slow Orders
Erecting Department
Testing Department
Hold for Shipping Instructions
Shipping Department

FIGURE 106. *Route of production record strips on planning department control boards*
The items listed are headings over the consecutive sections of the boards.

the orders are sent to the engineering department for the working up of specifications, drawings and bills-of-material, the sticks are pulled off the first row of pipes and placed on the second under "Engineering." As the engineering department finishes its work on orders, the corresponding sticks are clipped temporarily on the row of pipes marked "Planning." When the planning department is ready to route the orders through the shop, the production control department moves the sticks over to one of the three shop-processing columns. Upon completion of the work on the various parts, the sticks are placed in turn on the "Erecting" column, the "Testing" column and the "Shipping" column, according to the stage that the various orders have reached. If the customer is not ready for the machines, the sticks go on the "Waiting for Shipping Instructions" column.

SCHEDULE OF SHIPPING DATES

A separate board, carrying horizontal holders for small cards and having days of the month across the top, is used to schedule shipping dates. A card for each order is put under the promised date. A movable string marks the current date. The close approach of shipping dates is thus graphically indicated and steps can be taken to push a lagging order.

Hence, once an order strip is made out and mounted on a stick, it becomes a unit which is moved physically from board to board merely by the simple operation of pulling the stick off one row and slipping it on the next in sequence. The number of strips on any one column shows the work in that particular department. Detailed steps in processing are checked off as finished, by entries with corresponding dates in the correct columns on the strips. The status of every order is graphically shown. Any delays in work are known to everyone concerned, because of visible evidence on the control board. The cause of the delay is shown. Anyone can look over the board and see exactly the condition of the work throughout the entire plant. In addition, clerical work in operating the system is cut to a minimum.

MATERIAL CONTROL BOARD

To make the method still more effective a "Material" board has been installed as an auxiliary control device. It is built along the same lines as the regular production control board and uses the same mechanisms. Strips containing columns for the entry of data listed in Column C of Table 12 are employed. The parts made or processed go into stock for assembly in filling regular production orders.

The operation of this system is as follows: The sales department, for instance, forecasts that on the basis of past experience, market data and sale-trends, 500 5-hp. squirrel cage motors will be sold during the next 6 months. They then start an order for 500 frames. The corresponding board-strip goes to the "Order" column, then to the "Planning" column and then it is taken off and goes to the "Material" column. Here the lot orders are divided into three classes, which are each assigned a vertical row on the material board. These classes are: (1) Lots Assigned, Material to be Ordered; (2) Working Board for Machine Shop; (3) Core Department.

As the work called for under each of these classes is performed, the strips are moved to the next. In this way the mechanical department is able to schedule and make up the parts in large and economical manufacturing lots, according to pre-estimated sales volume. The procedure is outlined in Figure 107, and covers the processing of cast iron, steel, malleable iron and similar metal parts for generators and motors.

The order-of-work is laid out by the planning department, and no deviation from schedule is permitted unless sanctioned by the planning department, which, of course, operates under the direct supervision of the superintendent. (See Figure 108.)

Certain details of the production control system will explain its practical operation. Daily check-ups are necessary to enable the system actually to control, and not just represent a history of production. Each foreman makes out for the planning department a daily report of the work his men have completed. (See Figure 109.) On the board-strips corresponding entries are made showing the work done, with dates. If the work is delivered to the next department, the sticks are moved accordingly.

Once a day the head of the planning division, who knows the manufacturing operations thoroughly, goes through the plant and personally checks up on the progress of the work as laid out by the method illustrated in Figure 108. He records the data on his control boards and takes steps to get slow jobs moving.

In passing, it must be mentioned that the enthusiastic co-operation of this man has materially assisted in making production control successful. He arrives at the plant daily at 5:40 A.M. and has all his checking done and boards adjusted by 7 A.M. When the shop men come to work, and later, when the office men arrive, everything is in shape to tackle the exceptions to the regular flow of work and correct any troubles. Of course, this man leaves early in the afternoon, while the rest of the force follow the usual plant hours.

Inventory control ties directly in with production control. Methods are being continually improved in this branch of the work.

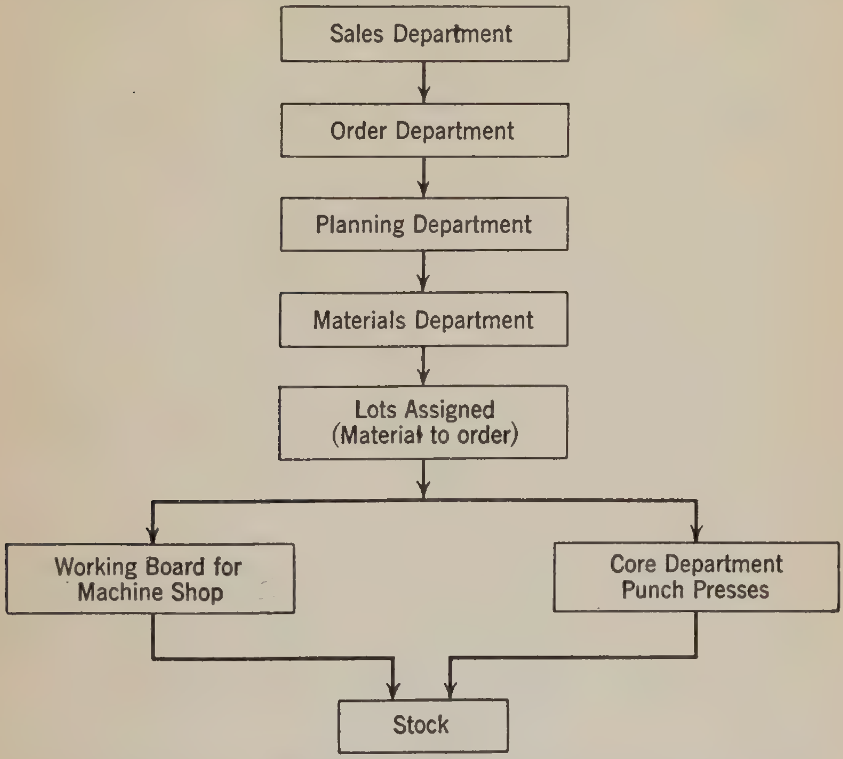
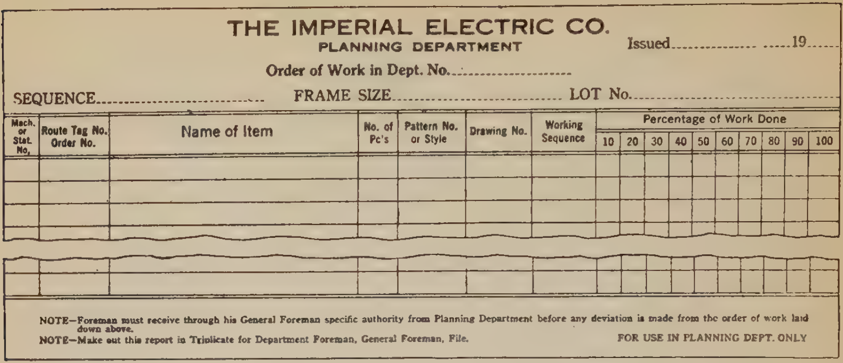

Sales Department
Order Department
Planning Department
Materials Department
Lots Assigned (Material to order)
Working Board for Machine Shop
Core Department Punch Presses
Stock

FIGURE 107. *Route of material record strips on planning department control boards*

The last four are the headings over the consecutive sections of the boards.

The perpetual inventory is kept on sheets in loose-leaf books. Apportionments to orders are entered and stock issues are charged out by the usual procedure followed in such systems. Minimum stocks, or "order points," and quantities to order are established and modified from time to time to suit changes in sales and production



THE IMPERIAL ELECTRIC CO.
PLANNING DEPARTMENT
Issued.................. ......19......
Order of Work in Dept. No..........................
SEQUENCE.............................. FRAME SIZE.............................. LOT No...................................

Mach. or Stat. No.	Route Tag No. Order No.	Name of Item	No. of Pc's	Pattern No. or Style	Drawing No.	Working Sequence	Percentage of Work Done									
							10	20	30	40	50	60	70	80	90	100

NOTE—Foreman must receive through his General Foreman specific authority from Planning Department before any deviation is made from the order of work laid down above.
NOTE—Make out this report in Triplicate for Department Foreman, General Foreman, File. FOR USE IN PLANNING DEPT. ONLY

FIGURE 108. *Order-of-work form controlling production sequence*

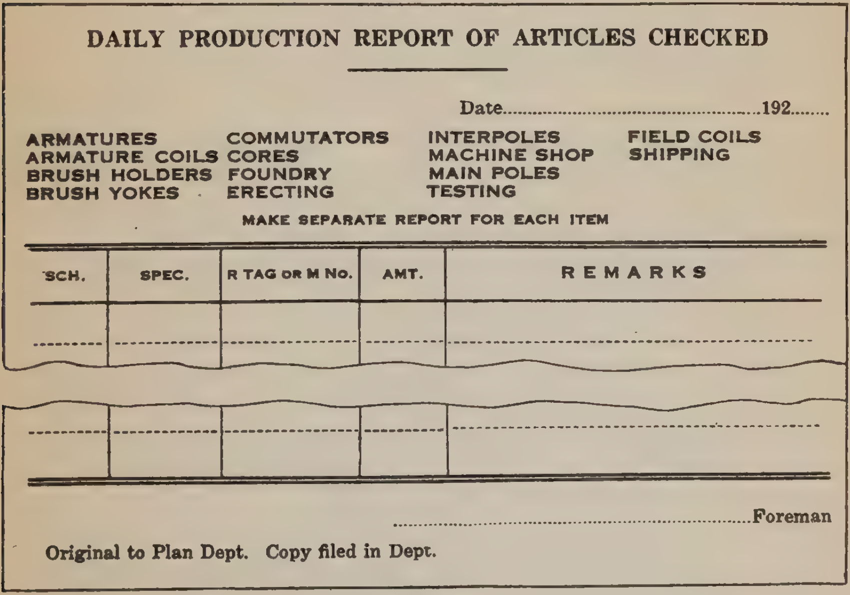
programs. This control, however, is not considered a check complete enough to accomplish the required objective, namely, to have enough material on hand when needed for orders but to carry no excessive stocks.

Hence the superintendent has built up a comparative record system of loose-leaf sheets, classified by types and sizes of machines and containing lists of required parts. For items like shafting, copper bar stock, mica, etc., the materials are grouped under these heads. On the sheets alongside of each item are entered the quantity used last year, the book inventory, the check by physical count at stated periods, the quantity on order, and the quantity available. These sheets might be called abridged combinations of bills-of-material and perpetual inventory sheets, according to the specific kinds of machines. When an order for these machines comes along, a quick inspection of the records at once tells the condition of the stock. Shortages are eliminated by this plan, and shipping dates, or completion dates for stock machines, can be set and reported at once to the sales departments.

This method is much more rapid and direct than going through the perpetual inventory records, and physical counts on important stocks can be made continually, instead of intermittently as under the regular inventory routine. There is some duplication of records, but the counts made for special records are always reported to the balance-of-stores clerk, so the checking work is not duplicated. Moreover, it must be said of the system that it gives far more direct control, by setting shipping dates that are lived up to, than is obtained by the longer and more intricate process under the ordinary perpetual inventory routine.

Where shortages threaten, due to unexpectedly heavy orders, a "rush material" card is filled out which gives the items in question precedence in manufacturing or purchasing. This card carries spaces for dates under the following headings "Reported in Process," "Ordered," and "Here."

Purchasing has been co-ordinated with sales and production. About 6,500 items must be bought, of which 5,500 are purchased at frequent intervals. All purchase requisitions must be approved by the president. Inquiries are sent out in triplicate, where feasible, to get competitive prices. Certain materials, of course, are contracted for on long-time commitments and are then ordered in as needed. For instance, standard castings obtained from an outside foundry are bought on commitments, cast and stocked according to the convenience of the maker, and then shipped in carload lots comprising different types and sizes, as specified by the production department for each shipment. Sheet steel, hardware and metals are likewise contracted for in large quantities, to give the makers the opportunity to produce at lowered costs, and are stocked by the vendors



DAILY PRODUCTION REPORT OF ARTICLES CHECKED

Date...192........

ARMATURES
ARMATURE COILS
BRUSH HOLDERS
BRUSH YOKES
COMMUTATORS
CORES
FOUNDRY
ERECTING
INTERPOLES
MACHINE SHOP
MAIN POLES
TESTING
FIELD COILS
SHIPPING

MAKE SEPARATE REPORT FOR EACH ITEM

SCH.	SPEC.	R TAG OR M No.	AMT.	REMARKS

....Foreman

Original to Plan Dept. Copy filed in Dept.

FIGURE 109. *Daily departmental report from foremen*

and delivered on separate shipping orders issued against these stocks.

Purchase orders are made out in multiple as follows: White to vendor; yellow, receiving department; blue, materials department for entry on balance-of-stores and filing in a numerical file; pink, filed consecutively by purchasing department; green, cross file, clipped to invoice and copy of receiving department report when goods arrive, and sent to accounting department; cherry, purchasing department follow-up, filed according to vendor.

The purchasing department card records are classed into four divisions: Office supplies, factory supplies, materials to be processed, and materials bought as finished items for re-sale to customers (motor control equipment, special pulleys, etc.). These cards show vendors and commodities, how much is on order, and how receipts are to be scheduled. The total expenses in each division are checked up and regulated in this manner.

The president receives a copy of each purchase order, and also daily reports of invoices received and the running balance on each order. He is thus informed as to what orders are unfilled, what are in transit, the materials received but not billed, and suspense items. As a result he knows the payments due each day on purchases and can regulate the finances of the business accordingly.

The purchasing department operates a control board, consisting of sticks carrying cardboard strips and mounted by spring clips on pipe holders, in the same manner as that employed for the production control board. For special items, such as controllers, it makes up its own strips. For items which may not arrive until after machines have been shipped to customers (like pulleys, etc.), it uses the planning department control strips.

COST REDUCTION AND OTHER RESULTS

By this close co-ordination of sales, purchasing and production, four objectives have been realized: (1) meeting of shipping date promises in practically 100 per cent of cases; (2) a 25 per cent reduction of inventory; (3) a 20 per cent reduction of costs; (4) improved and increased service to customers. These benefits have been brought about by better production control and the opportunities made use of to reduce time on operations by improved methods of work.

CONTROL METHODS THAT TRIPLED PRODUCTION

By A. B. KIBBLE
Manager of Production Control, Plant No. 2, Goodyear Tire and Rubber Company

A FORCE of 388 men, comprising the production service division of the Goodyear Tire and Rubber Company, helps the company to save millions of dollars annually in operating expenses. Manufacturing activities are thoroughly organized and definitely co-ordinated with sales. In spite of an immense volume of business, production control keeps accurate tabs on every item at all stages of manufacturing. This article gives the details of the system, of which the general operation and immense savings have been described in previous articles by two other executives of the Goodyear production control division. The same sound methods, adapted to any concern, large or small, engaged in continuous process manufacturing, will produce corresponding reductions in cost.

During the past four or five years the details of production control in the Goodyear plant have been worked into a comparatively direct and simple procedure, considering the vast scope of the business. The fundamentals upon which they are based, and some of the results secured, have been described previously. The present article will take up the question of how the manufacturing program is laid out and work put through the plant.

In order to have a simple unit for scheduling purposes, all jobs are broken down into machine-minutes and assigned on this basis.

WORKERS' INTERESTS GUARDED

In order to eliminate discontent on the part of the piece-worker, earnings over an 8-hour period must be considered at the time the schedules are written. Each schedule or order received from the merchandise distribution is broken down into production minutes and a chart is posted at intervals during the day showing work ahead of each group of machines. By the use of this chart a decision is reached as to the number of machines and working shifts required.

A mathematical break-down of incoming orders, of course, is not difficult, but a schedule properly co-ordinating equipment, labor and material and synchronizing one department with another is a task of unusual difficulty. It has therefore been found necessary to station at different control points throughout the plant a dispatching organization whose duty it is to assign work in accordance with the predetermined schedule, and to keep the schedule men located in central control correctly informed in regard to back schedules, new or inexperienced labor, and various other kinds of information essential to that function.

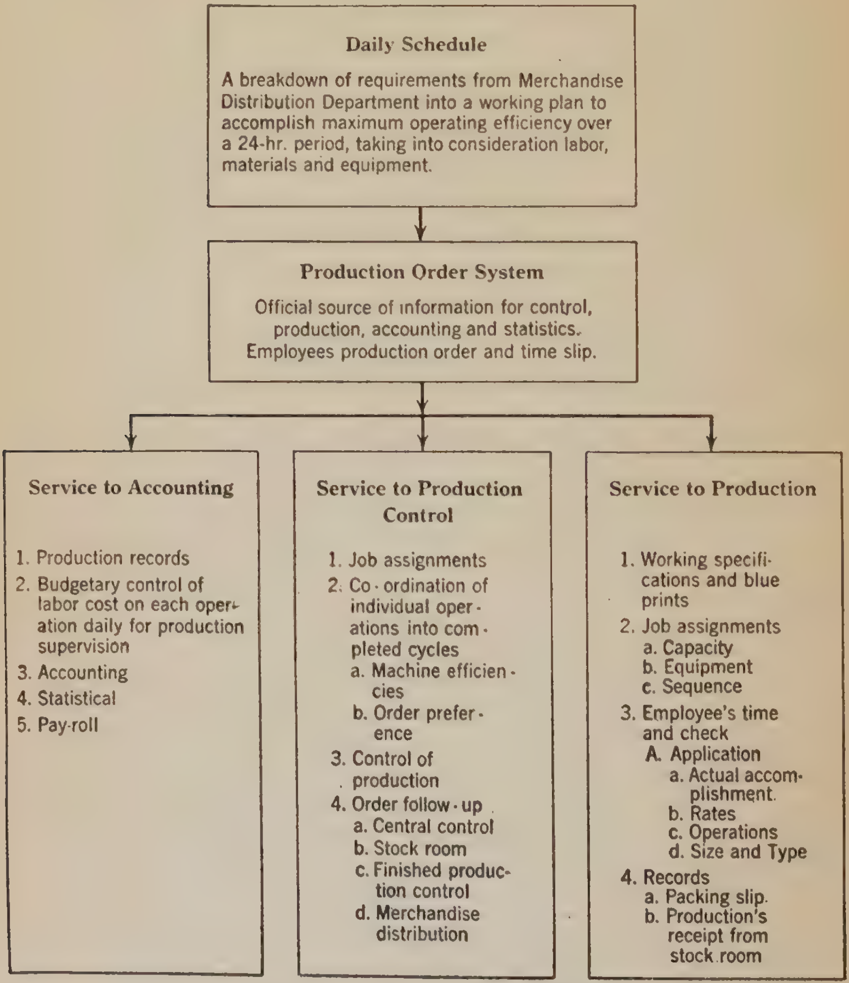

Daily Schedule
A breakdown of requirements from Merchandise Distribution Department into a working plan to accomplish maximum operating efficiency over a 24-hr. period, taking into consideration labor, materials and equipment.
Production Order System
Official source of information for control, production, accounting and statistics.
Employees production order and time slip.
Service to Accounting
1. Production records
2. Budgetary control of labor cost on each operation daily for production supervision
3. Accounting
4. Statistical
5. Pay-roll
Service to Production Control
1. Job assignments
2. Co-ordination of individual operations into completed cycles
a. Machine efficiencies
b. Order preference
3. Control of production
4. Order follow-up
a. Central control
b. Stock room
c. Finished production control
d. Merchandise distribution
Service to Production
1. Working specifications and blue prints
2. Job assignments
a. Capacity
b. Equipment
c. Sequence
3. Employee's time and check
A. Application
a. Actual accomplishment.
b. Rates
c. Operations
d. Size and Type
4. Records
a. Packing slip.
b. Production's receipt from stock room

FIGURE 110. *General scheme of factory production control*

The centralized control of all schedules and the assignment of work to machines throughout the plant is the only method by which production can be regulated to assure harmony and uniform operating conditions.

In the case of the tire room, where machines are definitely assigned to certain size tires, and are operated for days or weeks on this basis, the dispatching function is one of mainly keeping process inventories properly in balance. However, in the case of certain mechanical goods departments, where a job may represent a few minutes' production work on a machine, and never over a few hours, the task of keeping the machines properly supplied with work, without delays, is rather difficult.

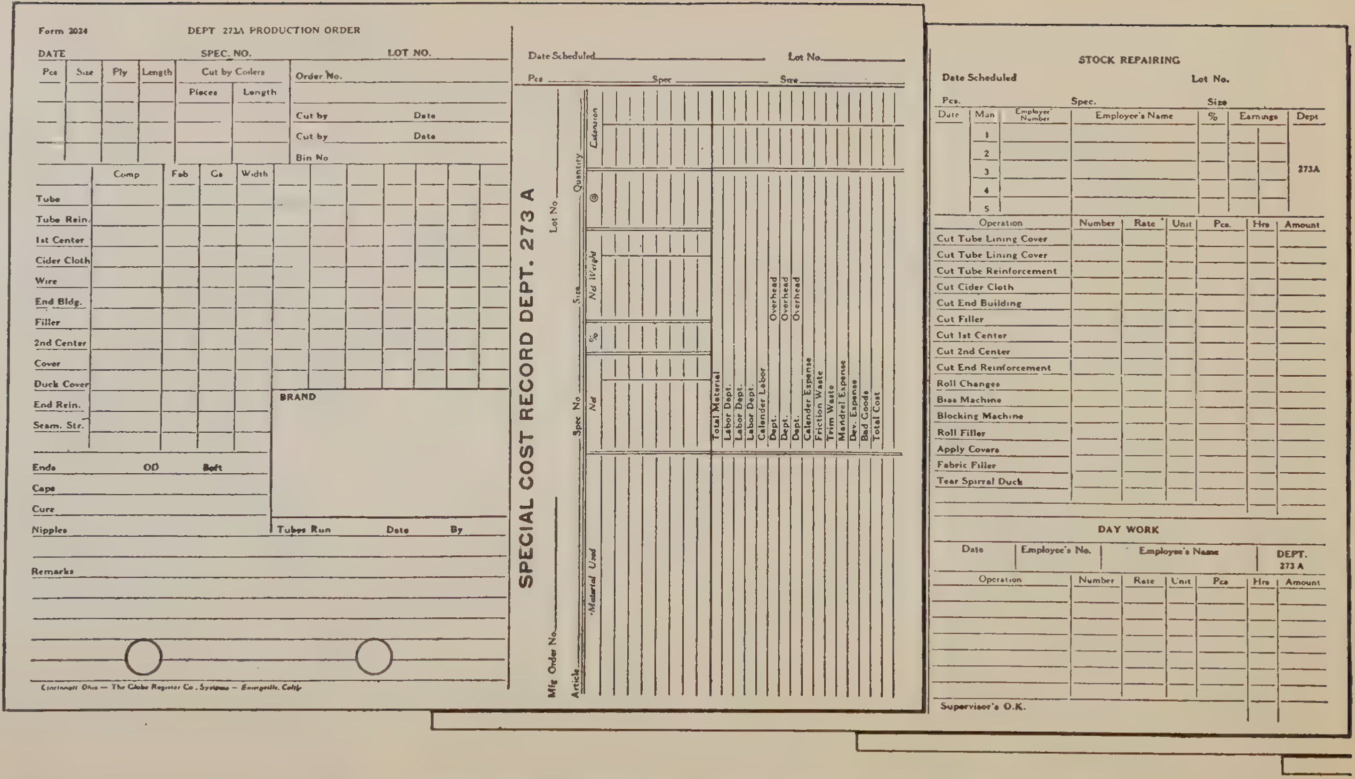
To assist in this work, the dispatcher is provided with production or job assignment orders, numerically numbered, outlining the specification of the particular product on order. Dispatch boards have been installed and these orders are so arranged on the boards that the condition of the department is semi-graphically outlined.

By the use of this method, the production control organization dispatches material through all operations in production and into finished stock and shipping departments. The design of the production or job assignment order, which is the authority to manufacture all products, varies with departments.

The assignments are typewritten and represent the largest amount of product which can be economically routed through the different departments without producing congestion, but keeping all machines busy and providing an orderly sequence of performance.

The assembly of the production assignment order is composed of as many copies and colors as are required for assigning work to each individual operation, maintaining the records necessary for dispatching and the rendering of the operator's or crew's time.

In the control of rubber hose, which is representative of the other mechanical goods departments (see Figure 112), the production and assignment order consists of six copies (Figure 111): First, special white, this copy goes to the cost department; second, white copy goes to stock-cutting operation; third, blue copy goes to tubing operation; fourth, yellow copy goes to building operation; fifth, salmon copy goes to finishing operations; sixth, pink copy goes to finishing and assembling operations. Each particular copy is sent



Form 2024 DEPT 273A PRODUCTION ORDER

DATE SPEC. NO. LOT NO.

Pcs	Size	Ply	Length	Cut by Cutters Pieces	Cut by Cutters Length	Order No.

Cut by Date
Cut by Date
Bin No

	Comp	Fab	Ga	Width
Tube				
Tube Rein.				
1st Center				
Cider Cloth				
Wire				
End Bldg.				
Filler				
2nd Center				
Cover				
Duck Cover				
End Rein.				
Seam. Str.				

BRAND

Ends OD Soft
Caps
Cure
Nipples
Tubes Run Date By

Remarks

Cincinnati Ohio — The Globe Register Co. Systems — Emeryville, Calif.

SPECIAL COST RECORD DEPT. 273 A

Date Scheduled Lot No.
Pcs Spec Size

Mfg Order No. Lot No.
Article Spec No Size Quantity

Material Used
Net
%
Net Weight
@
Extension

Total Material
Labor Dept.
Labor Dept.
Labor Dept.
Calender Labor
Dept. Overhead
Dept. Overhead
Dept. Overhead
Calender Expense
Friction Waste
Trim Waste
Mandrel Expense
Dev. Expense
Bad Goods
Total Cost

STOCK REPAIRING

Date Scheduled Lot No.
Pcs. Spec. Size

Date	Man	Employee Number	Employee's Name	%	Earnings	Dept
	1					
	2					
	3					273A
	4					
	5					

Operation	Number	Rate	Unit	Pcs.	Hrs	Amount
Cut Tube Lining Cover						
Cut Tube Lining Cover						
Cut Tube Reinforcement						
Cut Cider Cloth						
Cut End Building						
Cut Filler						
Cut 1st Center						
Cut 2nd Center						
Cut End Reinforcement						
Roll Changes						
Bias Machine						
Blocking Machine						
Roll Filler						
Apply Covers						
Fabric Filler						
Tear Spiral Duck						

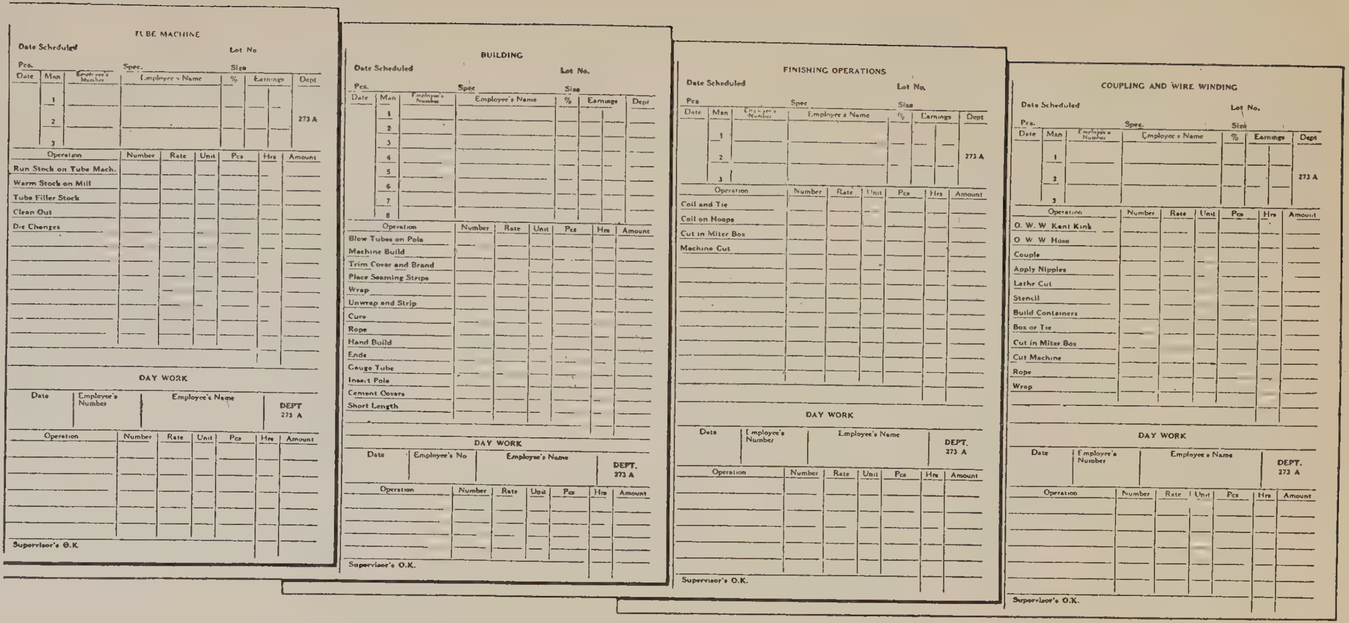
DAY WORK

Date	Employee's No.	Employee's Name	DEPT. 273 A

Operation	Number	Rate	Unit	Pcs	Hrs	Amount

Supervisor's O.K.

FIGURE 111. *Production order for the manufacture of woven hose. Seven copies are made, three are shown here and four on the next page, each providing for insertion of data by the various departments*



TUBE MACHINE

Date Scheduled Lot No

Pcs. Spec. Size

Date	Man	Employee's Number	Employee's Name	%	Earnings	Dept
	1					
	2					273 A
	3					

Operation	Number	Rate	Unit	Pcs	Hrs	Amount
Run Stock on Tube Mach.						
Warm Stock on Mill						
Tube Filler Stock						
Clean Out						
Die Changes						

DAY WORK

Date	Employee's Number	Employee's Name	DEPT 273 A

Operation	Number	Rate	Unit	Pcs	Hrs	Amount

Supervisor's O.K

BUILDING

Date Scheduled Lot No.

Pcs. Spec Size

Date	Man	Employee's Number	Employee's Name	%	Earnings	Dept
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					

Operation	Number	Rate	Unit	Pcs	Hrs	Amount
Blow Tubes on Pole						
Machine Build						
Trim Cover and Brand						
Place Seaming Strips						
Wrap						
Unwrap and Strip						
Cure						
Rope						
Hand Build						
Ends						
Gauge Tube						
Insert Pole						
Cement Covers						
Short Length						

DAY WORK

Date	Employee's No	Employee's Name	DEPT. 273 A

Operation	Number	Rate	Unit	Pcs	Hrs	Amount

Supervisor's O.K.

FINISHING OPERATIONS

Date Scheduled Lot No.

Pcs Spec Size

Date	Man	Employee's Number	Employee's Name	%	Earnings	Dept
	1					
	2					273 A
	3					

Operation	Number	Rate	Unit	Pcs	Hrs	Amount
Coil and Tie						
Coil on Hoops						
Cut in Miter Box						
Machine Cut						

DAY WORK

Date	Employee's Number	Employee's Name	DEPT. 273 A

Operation	Number	Rate	Unit	Pcs	Hrs	Amount

Supervisor's O.K.

COUPLING AND WIRE WINDING

Date Scheduled Lot No.

Pcs. Spec. Size

Date	Man	Employee's Number	Employee's Name	%	Earnings	Dept
	1					
	2					273 A
	3					

Operation	Number	Rate	Unit	Pcs	Hrs	Amount
O. W. W Kent Kink						
O W W Hose						
Couple						
Apply Nipples						
Lathe Cut						
Stencil						
Build Containers						
Box or Tie						
Cut in Miter Box						
Cut Machine						
Rope						
Wrap						

DAY WORK

Date	Employee's Number	Employee's Name	DEPT. 273 A

Operation	Number	Rate	Unit	Pcs	Hrs	Amount

Supervisor's O.K.

along with the material and after the completion of the operation, the supervisor writes on the face of the copy the name of the operator who did the work, the quantity turned out and the time required.

After the different copies of the assignment order have served their purpose in dispatching material through the production departments, three copies of order accompany the material to the stockroom. One copy is receipted and returned to the production control department where it is filed for reference on deliveries, in case any question arises after the material is shipped. Another copy goes to finished products control which tabulates and informs the merchandise distribution department that the product is available for shipment. The third copy is retained by the stockroom for use in identifying the material.

After notification from the finished products control that material is available for shipping, the merchandise distribution department releases the shipping copies of the order. The shipping department copy and the billing copy are filed away with the original order. Under this system, information regarding the location of material at any point is readily obtained.

The sales, or merchandise distribution, department may want to know what stage the order has reached in the plant. The control boards in the local dispatching stations show where the work is at all times. The merchandise distribution department contacts with the central control division and is promptly given any information requested.

The central control, in addition to typing the production assignment orders, also prepares all identification tags for materials-in-process and the finished product. Tags play a very important part in control and serve many purposes other than identification.

Working under the supervision of the schedule men who formulate the daily machine schedules, are estimators whose duty it is to break down the production assignment orders into the actual raw materials required and order all materials from the storerooms and the preparatory departments. This personnel is also responsible for actually placing orders for all productive material. A storeroom requisition card is used in dispatching raw materials to the different departments, while calender tags are used for gum and frictioned

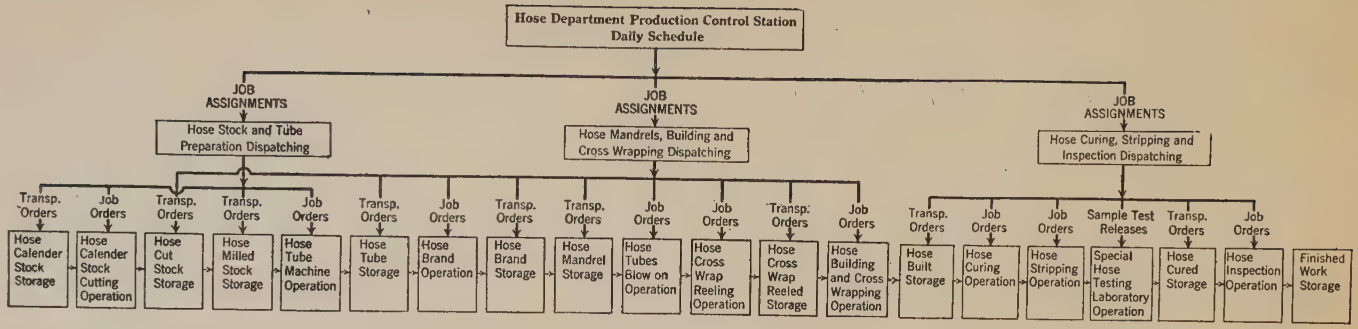

Hose Department Production Control Station Daily Schedule
JOB ASSIGNMENTS
Hose Stock and Tube Preparation Dispatching
JOB ASSIGNMENTS
Hose Mandrels, Building and Cross Wrapping Dispatching
JOB ASSIGNMENTS
Hose Curing, Stripping and Inspection Dispatching
Transp. Orders
Hose Calender Stock Storage
Job Orders
Hose Calender Stock Cutting Operation
Transp. Orders
Hose Cut Stock Storage
Transp. Orders
Hose Milled Stock Storage
Job Orders
Hose Tube Machine Operation
Transp. Orders
Hose Tube Storage
Job Orders
Hose Brand Operation
Transp. Orders
Hose Brand Storage
Transp. Orders
Hose Mandrel Storage
Job Orders
Hose Tubes Blow on Operation
Job Orders
Hose Cross Wrap Reeling Operation
Transp. Orders
Hose Cross Wrap Reeled Storage
Job Orders
Hose Building and Cross Wrapping Operation
Transp. Orders
Hose Built Storage
Job Orders
Hose Curing Operation
Job Orders
Hose Stripping Operation
Sample Test Releases
Special Hose Testing Laboratory Operation
Transp. Orders
Hose Cured Storage
Job Orders
Hose Inspection Operation
Finished Work Storage

FIGURE 112. *Chart showing organization of department control and dispatching procedure for rubber hose production in plant No. 2*

Solid lines show course of orders. Kind of order is indicated on each line. Dash lines show course of product through operations performed on it in the department. Movement of the material designated between operations is executed in many cases by machine operators.

stock. Orders must also be placed on the compounding and milling departments; these operations are performed prior to calendering.

To prevent disrupting the production cycle, which causes considerable expense, and to provide ample time for processing materials through the preparatory departments, schedules for the mechanical goods departments are written daily and production assignment orders issued which are scheduled for the building operation four days later. Emergency orders are exceptions to this practice.

The management of the company uderstands and co-operates heartily in maintaining schedules as formulated and support is given to every move made to iron out difficulties and strengthen weak links.

The merchandise distribution department sends orders for special products directly to the production control division within two to three hours after they arrive. The order is first checked for materials. The production control division then reports back to the merchandise distribution department on its ability to handle such orders, and approximately when they can be filled and shipped. If they are of an extent to require additional equipment and labor, the production control division arranges with the labor department to secure more men, and with the equipment control department to furnish more molds, dies, etc. The engineering and planning departments are called upon to specify any additional machines needed. The plant layout department handles the ordering and installing of these machines.

On special orders for such products as belting, piece-work rates are used to figure the building time. The daily schedule is based on production-minutes. It states the minutes of production received in the form of orders, the minutes scheduled for the day, the minutes actually built and the minutes, plus or minus, carried over to the next day's schedule.

The importance of having the preparatory departments deliver processed materials when needed is evident. In industries assembling from parts a reserve stock of finished parts can be built up to supply final operations. In a continuous process industry each step depends directly upon the previous step. Moreover, where two or three shifts per day are running, the work cannot be stopped for a backward preparatory department. The losses are too tremendous.

SIMPLIFIED PRODUCTION CONTROL

By K. R. WOOD
Production Manager, Bell & Howell Co., Chicago

TO GET the necessary production and to control costs are after all the high spots of a production manager's duties. Not always an easy task! Particularly is this true in a plant manufacturing moving picture cameras and projectors, where we have a decidedly complex production control problem.

You might assume that in making such apparatus, the production problem would be similar to that of the automotive industry, in other words that the work would be of a continuous flow nature. But this is not the case, and for these reasons: For years we have manufactured more than one hundred cinema products assembled from thousands of different parts. Some of these products are made in lots of 100,000, some to order, and others used exclusively by the large studios are made in comparatively small quantities.

Then in addition to all the above came the development of Filmo cameras, projectors and accessories—a line for amateur use. With the advent of a rapidly growing popularity of the Filmo apparatus, the demand made it necessary first to double, then to treble our daily schedule of units. This, done almost without notice, naturally caused a deal of confusion. All this increase in output upset plans, demoralized control and brought into sharp focus the necessity for a system which would satisfactorily control not only small lots of a few pieces, but also those consisting of many thousands processed either en bloc or in instalments.

With this problem confronting us, I visited some of the leading manufacturers who were faced with similar production control problems, and sought a possible solution.

It became increasingly evident that what I wanted to accomplish was a bringing together, to as great an extent as possible, of the control and operating departments. In actuality, they must of necessity cover a widespread area. How then to bring them together. Obviously this must be accomplished by some sort of distance-annihilating device as a signaling system.

Such a system I found in use in a concern manufacturing fish nets. Like so many things in the management world, it could not be taken over bodily into our plant, but it did seem to me that the

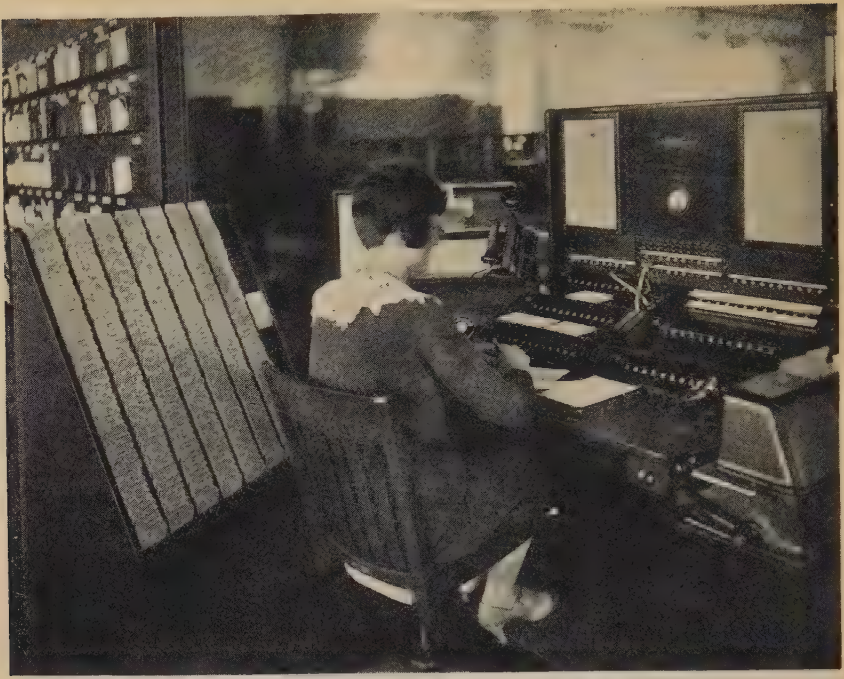


FIGURE 113. *Central control station. Time stamp at operator's left; and farther at left, but within arm's reach, the visible index*

idea had application with certain changes to meet our peculiar conditions.

The long and short of it is that, by its adaption, I have worked out a simplified production control system for our use, which makes it possible to ascertain directly at completion of a job whether or not the performance was according to plan. And the status of each job is known at a central control desk at any instant during the day—not at the end of the day, or tomorrow, but *now*.

Directing activities in the factory with shop orders is of course not new, but a shop order which co-ordinates the control department and the production departments—which brings them to all intents and purposes within the same small room under the gaze of one man—is what we have attempted to work out, and we believe we have accomplished it.

In perfecting this system I have retained the good features of the methods we have been using all along, including a carefully designed "shop paper" or work-scheduling plan instrumental in directing activities in the factory, and an "office paper" whereon are accumulated the various elements entering into manufacturing cost. In addition we have adopted a signaling system for announcing to a central control department employee every time one job is completed and the next started.

The signaling device, by its ability to dispatch information electrically, in effect lessens the distance between the shop paper in the hands of the workman and the office paper at the central station.

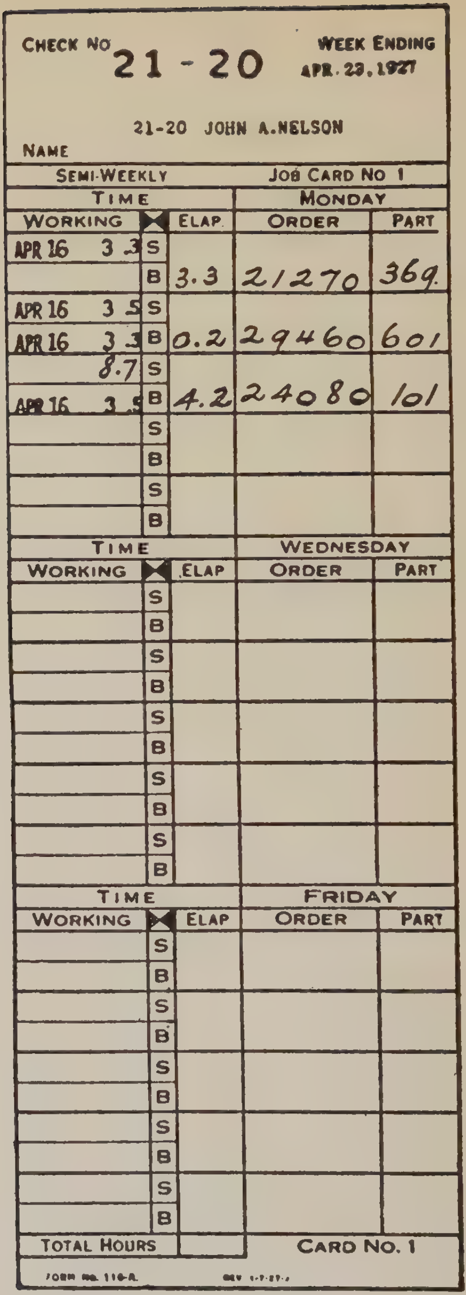
My objective has been to simplify control to allow our management to increase or even to double demands at will, without causing the usual confusion that would result in the factory under such circumstances.

I found that it was possible, if the shop paper were carefully designed, to accumulate at the same time information necessary to check the flow of work in process and to control it. The signaling system was installed and put in operation in the midst of our former production system without the necessity of alteration of the shop or office records and forms which we had been using. Thus, neither delay nor confusion was involved.

One of the important advantages which this installation has given us is the elimination of duplicated transcriptions of recorded information. Also, it has made it easy for our follow-up department to check delayed work, and it permits an almost unbelievable coordination between operating and planning departments as I shall shortly try to illustrate.

Now here is something of the detail by which we accomplish these results. In the first place, all departments have on file process cards printed on a blueprint sheet together with detail print. These show the procedure and give all instructions for executing the job. Production is planned as far ahead as possible: it is plotted from our standard process, something after the Gantt system with an allotted running time. From the production graph charts a routing order is made in quadruplicate (each of a different color) for each operation necessary to process a lot of parts completely through our plant.

Now let me digress sufficiently to outline only very briefly at this point the place of the signaling system. This consists of a series of substations which are located at points convenient to the workmen throughout the plant, and connected electrically to a central station located in our planning department. The outlying substations are



CHECK NO 21 - 20 WEEK ENDING APR. 23, 1927

21-20 JOHN A. NELSON

NAME

SEMI-WEEKLY JOB CARD NO 1

TIME			MONDAY	
WORKING	⧓	ELAP.	ORDER	PART
APR 16 3 3	S			
	B	3.3	21270	369.
APR 16 3 5	S			
APR 16 3 3	B	0.2	29460	601
8.7	S			
APR 16 3 5	B	4.2	24080	101
	S			
	B			
	S			
	B			

TIME			WEDNESDAY	
WORKING	⧓	ELAP	ORDER	PART
	S			
	B			
	S			
	B			
	S			
	B			
	S			
	B			
	S			
	B			

TIME			FRIDAY	
WORKING	⧓	ELAP	ORDER	PART
	S			
	B			
	S			
	B			
	S			
	B			
	S			
	B			
	S			
	B			

TOTAL HOURS CARD NO. 1

FORM No. 116-A. REV 1-7-27

FIGURE 114. *The job card, showing the order number, part number and time on the work*

transmitting stations from which information concerning start and finish of jobs is sent to the central receiving station and indicated visually before the central station operator.

At this central station, readily accessible to the operator, is a visible index containing the regulation pockets in which are placed the original (white) master control copy of the routing order just mentioned. The duplicate copy, which is yellow, is for department control purposes and goes to the foreman who also uses a visible index. The triplicate is blue and acts as a "traveler." It remains with the job itself. When the work is in actual process this traveled copy is attached to the machine, on which the work is being done, by a spring clip. The quadruplicate, or pink copy, serves as a memorandum and goes first to the tool storage crib for purposes of releasing the tools necessary for the operation to be performed. Then it is forwarded to the follow-up department and is filed against the date the work is to start.

The information on the routing order, as you will see from the accompanying illustration, Figure 115, is sufficient to direct all shop activities on the job, including the transfer of material and tools to the department which is to do the work. There are spaces across the bottom of the routing order to accommodate the order number, part number, design number, the number of the station or machine which is scheduled to do the work, the sequence of operation on the machine; also the number of pieces in the lot, and the allotted time for setting up the machine and running off the number of pieces to be made.

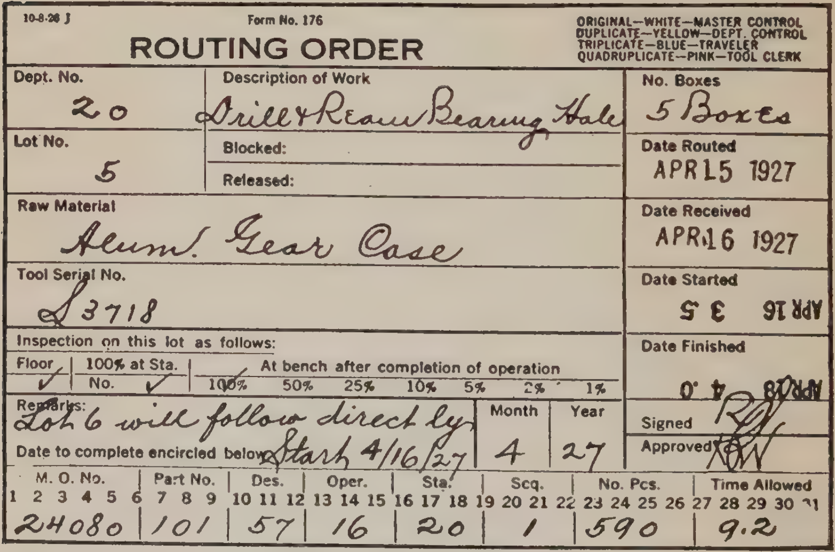
The foreman analyzes the work in his department from the orders posted on his visible index which constitutes a departmental control board. The planning department has so arranged and assigned the work that there are invariably two or more orders ahead of each work station at all times, thus permitting the foreman to release to a workman a new job just before the completion of the job in hand.

Now again let us get back to our signaling system to see how that enters into our production control plan. The medium for sending information from the various substations to the central receiving station is a dial similar to that used with automatic telephone equipment. Each time a digit or a symbol letter is dialed by the workman that digit or letter appears in front of the central operator and also in a window at the top of the sending unit. Thus the person dialing may be sure that all the figures are correct and as he intended them.

The letters referred to are symbols which give the various pieces of information as indicated on the accompanying list.

The way it works is this: When a workman has finished a job he steps to the nearest substation and signals for a line by means of a button on the unit. This signal appears at the central station where the operator plugs in on the line and the connection is indicated at the substation by a small red light which notifies the workman that the dialing may start.

The workman dials his number, order number, and other identifying information together with the symbol for "job finished." (There are in our apparatus twelve digits and symbols which are available, so that this number may be dialed without clearing the line. In our case these are arranged as follows: at the left one letter, then five digits then two letters and finally four digits.) While this is going on, the central operator is reaching for his copy of the routing order and the job card, Figure 114. These he stamps with a time clock in the "time finished" space. The signal indicator is then cleared and the workman similarly dials the start of a new job which is also



10-8-26 J
Form No. 176

ROUTING ORDER

ORIGINAL—WHITE—MASTER CONTROL
DUPLICATE—YELLOW—DEPT. CONTROL
TRIPLICATE—BLUE—TRAVELER
QUADRUPLICATE—PINK—TOOL CLERK

Dept. No. 20
Description of Work Drill & Ream Bearing Hole
No. Boxes 5 Boxes
Lot No. 5
Blocked:
Released:
Date Routed APR 15 1927
Raw Material Alum. Gear Case
Date Received APR 16 1927
Tool Serial No. S3718
Date Started APR 16 3 5
Inspection on this lot as follows:
Floor ✓ | 100% at Sta. No. ✓ | At bench after completion of operation ~~100%~~ 50% 25% 10% 5% 2% 1%
Date Finished APR 18 4 0
Remarks: Lot 6 will follow directly
Date to complete encircled below Start 4/16/27
Month 4 | Year 27
Signed
Approved

M. O. No. 1 2 3 4 5 6	Part No. 7 8 9	Des. 10 11 12	Oper. 13 14 15	Sta. 16 17 18	Scq. 19 20 21 22	No. Pcs. 23 24 25 26	Time Allowed 27 28 29 30 31
24080	101	57	16	20	1	590	9.2

FIGURE 115. *Routing order, from which full information as to shop work may be obtained*

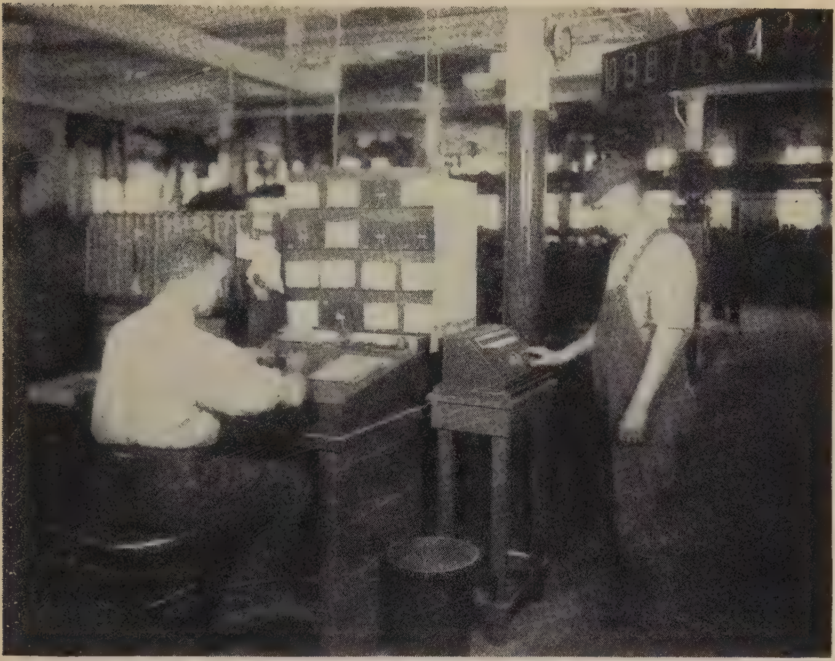
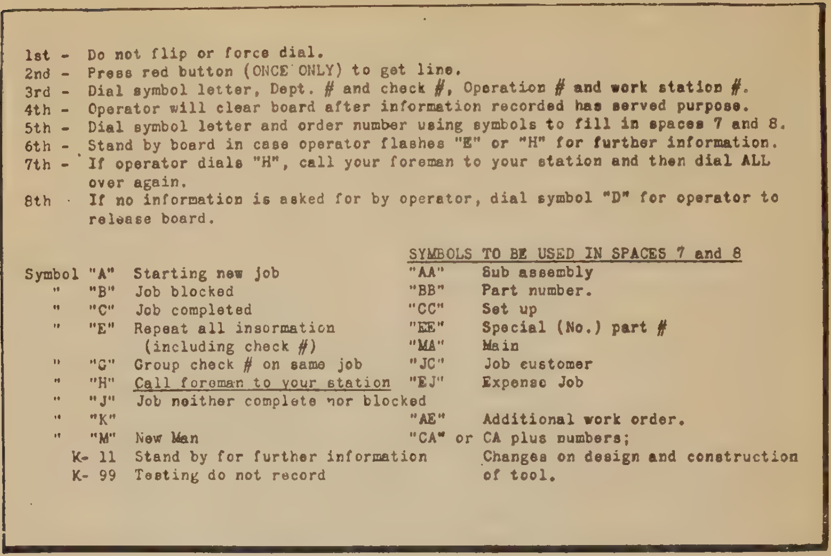


FIGURE 116. *One of the substations out in the plant. Workman is pushing re-set button which sets the readings back to blank again*

recorded as to starting time by time stamp. At the completion of a job and after the workman has dialed to that effect, the elapsed time is figured by the central operator on the job card, and the original copy of the routing order for the finished job is withdrawn from the visible control index and forwarded to the follow-up department where elapsed time is checked against the allotted time.

You might well ask what happens when more than one workman around the plant desires to dial at the same time. The answer is that at the central receiving station there are three sets of receiving apparatus—one on each panel as the illustration, Figure 113, shows. The operator soon becomes proficient enough to handle the three almost simultaneously.

It is our practice to state on the original and duplicate orders only of the routing order the number of hours allowed for set-up and running time for each operation. This information is, therefore, not available to the workmen, but is in the hands of the foremen and production control department only. The foreman analyzes his



1st - Do not flip or force dial.
2nd - Press red button (ONCE ONLY) to get line.
3rd - Dial symbol letter, Dept. # and check #, Operation # and work station #.
4th - Operator will clear board after information recorded has served purpose.
5th - Dial symbol letter and order number using symbols to fill in spaces 7 and 8.
6th - Stand by board in case operator flashes "E" or "H" for further information.
7th - If operator dials "H", call your foreman to your station and then dial ALL over again.
8th · If no information is asked for by operator, dial symbol "D" for operator to release board.

		SYMBOLS TO BE USED IN SPACES 7 and 8	
Symbol "A"	Starting new job	"AA"	Sub assembly
" "B"	Job blocked	"BB"	Part number.
" "C"	Job completed	"CC"	Set up
" "E"	Repeat all insormation (including check #)	"EE"	Special (No.) part #
		"MA"	Main
" "G"	Group check # on same job	"JC"	Job customer
" "H"	Call foreman to your station	"EJ"	Expense Job
" "J"	Job neither complete nor blocked		
" "K"		"AE"	Additional work order.
" "M"	New Man	"CA" or	CA plus numbers;
K- 11	Stand by for further information		Changes on design and construction of tool.
K- 99	Testing do not record		

FIGURE 117. *Instruction sheet for workman when dialing as to progress of a job*

work with the idea of maintaining or of bettering the number of hours allotted for each operation.

The principle of control on piece work is the same. It is handled in a similar manner; the only difference is that the workman in dialing his time, states the number of pieces made in the allotted time. The number of pieces is checked as the work is returned to the transfer department, and the production control department, in figuring elapsed time, checks against the time allowed at the rate on the number of pieces recorded. This, in turn, gives practically an automatic check against the piece work rate.

At first glance it might be natural to ask why we did not utilize a telephone system for transmitting this information between the work stations and the central operator and the control department. Such a system would have few of the advantages of the present method, and many disadvantages. For example, in the first place much conversation might go on over the telephone beyond that having to do strictly with the job in hand and we want to avoid that sort of thing. Then, too, we should have to teach each workman the proper way to pass the information in the interests of the efficient use of time.

As it is, just the information wanted and no superfluous facts are transmitted even by workmen unable to speak English. Then, too, as has already been mentioned, three workmen can be sending in their starting and stopping information simultaneously.

Under our present plan we get an immediate picture at all times of the exact status of all work in the plant and as a result we no longer need the services of a checker to gather up the evidence and piece it together after a lapse of considerable time.

This sort of work used to take up rather large proportion of the time of the foremen and their assistants. Now, however, they are free from these clerical tasks and can devote all of their time to the truer duties of foremanship.

PACKING JOINS THE ASSEMBLY LINE

By W. A. SMITH

Factory Manager, The Maytag Company, Newton, Iowa

TOO many manufacturers consider their jobs done when the products they make are off the assembly line. But packing is just as important as any process of making. The careful manager will see to it that the product is packed carefully, and at the lowest cost commensurate with a guarantee of delivery without breakage or pilferage. In other words, the manufacturing job is not done until the product reaches the dealer, if not the actual consumer. And this goes for any product whether it be large or small, liquid or solid.

Packing is to us, then, a prime manufacturing responsibility. We have put much thought into the problem of making the packing and shipping as smooth-running and expeditious as the assembly of the product. We have, therefore, utilized a conveyor to accomplish the desired result, and we have incorporated in the packing line as many simple mechanical aids as possible.

The beginning of our packing line is the hump (see Figure 118). Here one machine is just leaving the production line while the other slides down onto its crate base ready to start the packing operation. The same power that moves the final assembly line lifts the washer up onto the hump. Here the temporary casters drop out by gravity into chutes that return them to the beginning of the production line. The washer slides across and down onto its crate base. The slight impact starts the base moving down the gravity roller conveyor, where the same man who places the bases in position under the hump tacks on two strips that hold the washer on the base. From here the machine goes to the final inspection department located on either side of this conveyor. If it is found perfect, it rolls on into the packing department.

This hump saves the labor of at least two men who formerly were used to place the machines on their bases. In fact, it is doubtful whether two men could keep up with the production flow of 1,250 machines a day. With the hump there is no production bottle neck.

From the final inspection department, the washer rolls on down the conveyor to a point where a corrugated carton is slipped over the roller water remover (wringer). The entire water-remover assembly is then lifted off, later to be tucked into a corner of the wire-bound crate. Then, two-man crews literally wrap the crate around the washer and its base and top.

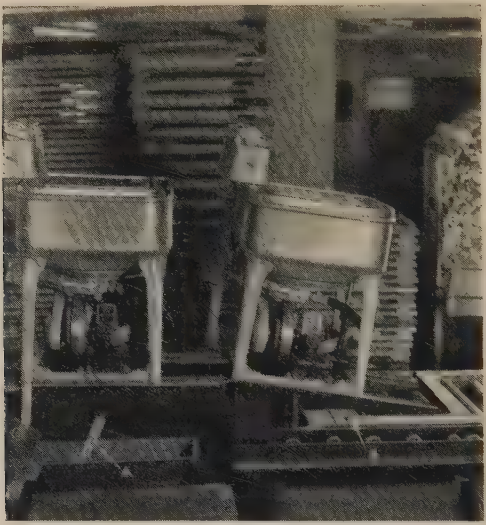


FIGURE 118. *As the washer is lifted onto the hump, the temporary casters fall out (A); the machine then slides down across its crate (B)*

As the packaged washer rolls on toward the shipping department, one man with a motor-driven tool twists the strong steel wires that bind the crate, entirely closing it. The speed and rhythm found on the assembly line continue in the packing department.

Incidentally, this crate, which has been used by The Maytag Company for four years, saves 11 lb. in shipping weight of each

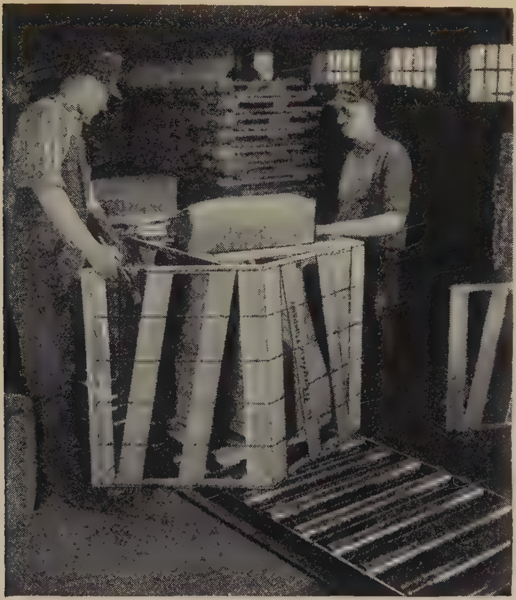


FIGURE 119. *Two-man crews wrap the crate around the washer and its base and top*

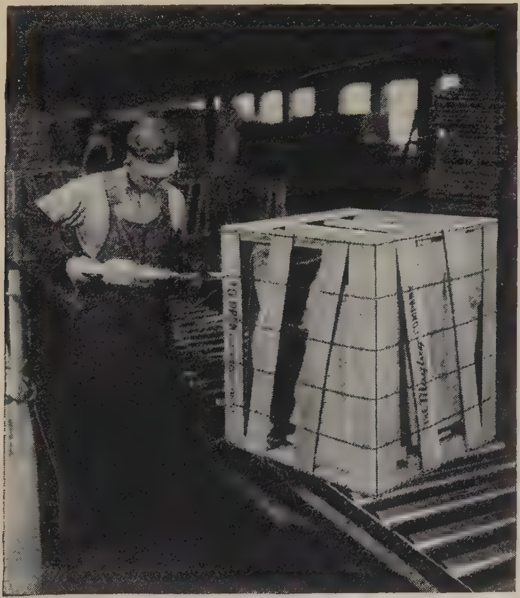


FIGURE 120. *One man, with a motor-driven tool, twists the steel wires which bind the crate*

packaged washer over the container formerly used, and which was made by the company itself. On the reasonable basis of 300,000 machines shipped yearly and an average freight rate of 80 cents, this means a saving to dealers of $26,400 in freight charges alone.

When the machines have been inspected and crated, they are chuted to the shipping platform, or off the line to storage. Looking back up this line (Figure 121), you see the packing crew, the crate closer, and the crates flowing through the entire department. The use of the wire-bound crate and this straight-line packing method has saved the company 10 cents per unit in packing charges.

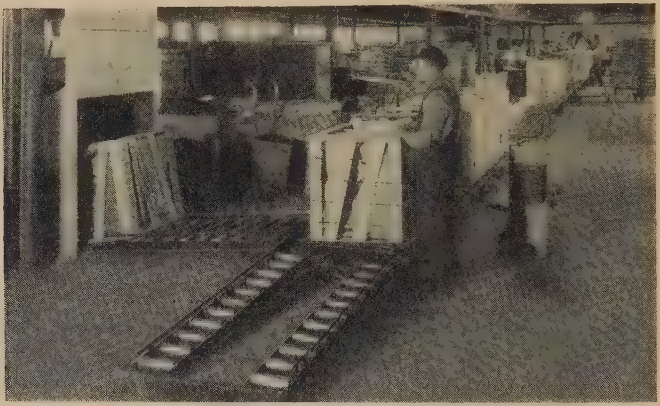


FIGURE 121. *Packing crew, crate closer, and crates flowing through the entire department can be seen in this picture. Wire-bound crates and a straight-line packing method saves 10 cents per unit in packing charges*

As the crates slide down the gravity chute to the shipping platform, they gain a certain momentum which must be checked to avoid damage. This is accomplished by suspending two short lengths of flat steel from the top angles of the chute frame at the outfall end of the chute. Between these pieces of flat steel, which serve as retarders, and the frame itself are steel springs. The retarders are so set that a crate slides into the guides and the momentum they have gained is broken by frictional resistance, the resistance being regulated by the springs. These, and the retarder on the floor, handle the crates as gently as could human hands.

Finally, the crates are sent either to storage or direct to cars for shipment. The unit method of storing crates in cars is almost universally followed. We are able to load a car in much less time than it took us formerly. The use of wire-tying machines is a factor in saving loading time.

Even in our storage department, great economies have been effected. The reduction in the size of the crate made possible by the shipping of the water remover in a corner of the crate instead of on top of the machine, together with the reduction in size made possible by using a wire-bound crate, has allowed us to stack three tiers of machines where but two tiers could be stored before. These changes in design not only allow fifty per cent more plant storage space, but allow the loading of 153 machines to a 40-ft. car instead of 102, the former maximum.

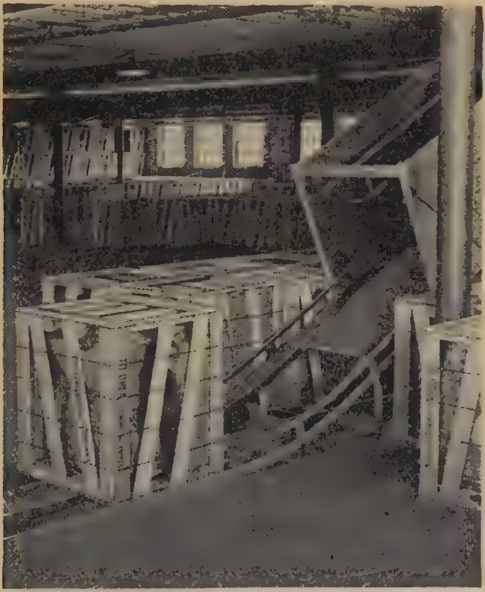


FIGURE 122. *Two short lengths of flat steel suspended from the top angles of the chute frame serve as retarders, preventing damage to the crates as they slide down the gravity chute*

There are other economic advantages to the new crate. Dealers can load more of them on a truck, and the crate can be unpacked in the consumer's house simply by snipping the wires and unwrapping them from the machine. There is no nail pulling, sawing, litter, or noise, and the housewife is sure she is getting a brand-new machine when the dealer unpacks it before her eyes.

The Maytag plan of straight-line packing, with its resulting economies, was based on extensive laboratory experiments. Packing, as well as many other processes, needs research to show the way to hidden profits.

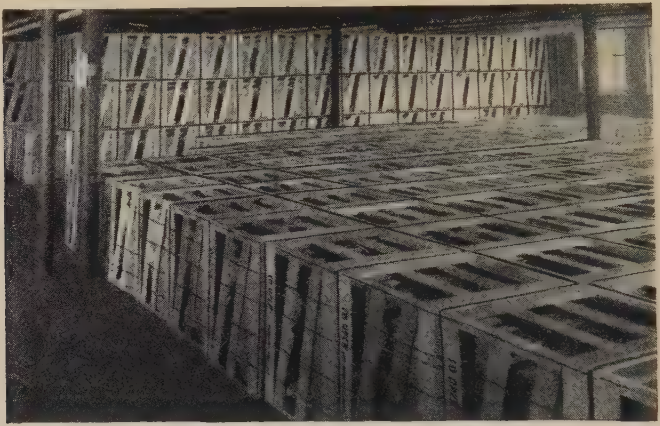


FIGURE 123. *Great economies have been effected in the storage department. Reduction in size of crate allows the stacking of three tiers of machines where but two could be stored before*

GIVE THE FACTS AND GET CO-OPERATION

BY ALFRED KAUFFMANN
President, Link-Belt Company

THE policy to "Treat 'em rough and tell 'em nothing" while a sort of vaudeville stage statement of caveman methods was not very far from the true relationship between management and employees in manufacturing establishments some years back. It wasn't always admitted nor was it by any means invariably applied with all its sinister inference. But the underlying point of view was that a firm hand together with a withholding of all except the most meagre information about the business was necessary in successfully handling factory men.

Today just exactly the opposite views are held by the majority of executives whose function is the handling of employees—and that means the majority of practically all executives.

THE CORRECT WAY

Not that soft dealing is required. Men don't want that. They don't like milk-and-water treatment, but they do want to know what it's all about. Most workmen today are intelligent enough to comprehend the facts and to use them constructively. Furthermore, in my opinion, they have a right to practically all the facts. But even if they didn't have, it would be good business to give the information, for the benefits would show up in the results.

I have said that I believe most workmen today are sufficiently intelligent to comprehend the facts and to use them. This statement implies a conviction that there has been a change—that the situation is not as it formerly was. I think most executives will agree with me that this is so, but why? And even if it is so and we find out why, what of it? Simply this, that a knowledge of the fact itself together with an understanding of the causes will show us, I believe, that new responsibilities exist on the part of management and new methods of approach are required in handling men. Furthermore, new and larger opportunities are opened up for gaining increased co-operation from the men. And this means greater team work.

So let us see what some of the reasons are for believing that workmen as a whole have a larger capacity than formerly for grasping the fundamental problems of business. In the first place, workmen live larger lives than formerly. They share in the fruits of the increased productivity of the nation. Aside from greater body comforts, the radio, the movie, the automobile have all contributed toward an elevation in the plane of living.

And this has been reflected in the mental make-up of the individual so that the white-collar complex of a few years ago has practically evaporated without a residue. The false barriers between office and factory employees which used to worry some executives is practically non-existent today.

THE NEW RELATION

This destruction of the conception of boss and bossed is altogether an entirely healthy move. It will have a lot to do with a shrinking of the crop of "yes men" which industry has grown in large numbers in the past. Men will more and more stand in a firmer position on their own feet, to the great gain of business as a whole.

That democracy in manufacturing organizations is already here is evident on every hand. Those of us in the thick of it see evidences in hundreds of ways throughout the day. But even a casual outside observer has only to notice the number of golf bags brought to the plant and office on a sunny Saturday morning in summer to sense a change in the working and playing habits of employees. Not many years ago, while a few of the top executives might stand their golf clubs up in a corner of the office in an anticipation of an afternoon's round on the links, for a sub-department head to bring his clubs to the plant would have been thought as out of place as wearing a bathing suit at a banquet.

Along with the other changes has gone the master-and-slave fear complex. Respect for ability and a sense of loyalty are better incentives to constructive action than all the compulsion in the world.

A better school education bearing on the principles and policies of business, together with a certain popularizing of the dry subject of economics, has perhaps played a part. So have the management magazines, management associations and the like.

EMPLOYEES AS STOCKHOLDERS

By no means least, however, as an influence, has been the ever-growing number of employees who are stockholders in the companies by whom they are employed, and in other concerns. Their income interests are no longer strictly confined to pay envelopes. Perhaps ever so slightly in some cases but yet existent is the capitalist's point of view on investments and the elements that make them sound.

Now this change of viewpoint which has come over the great majority of employees brings with it decided advantages to business as a whole, if the change is sensed by management. Otherwise it may have a negative effect in the individual concern. For good men, eager to learn some of the "why" as well as the "how" of their jobs, are likely to be drawn away from their present positions and attracted to that other concern where a more enlightened management prevails—a management that has fewer barriers between boss and bossed and that sees the value of taking workmen into their confidence.

A CASE WHERE CO-OPERATION PAID

As an example of what it means in the interest of good management to be able to share some of your problems with these present-day employees take that offered by a case we had where a job was taken on what promised to be rather a dangerously narrow margin of profit. We called in all the foremen and sub-foremen who were to work on the job and explained all the circumstances. We told them that we counted upon every man to put his whole interest into it with the idea of holding costs to the very minimum. These foremen and sub-foremen in turn took the message to the men in the shop. When put up in this way it is perfectly natural that every individual will do his best.

Nor is this an isolated case. We do it repeatedly where the circumstances warrant. But of course the edge would be taken off and the advantage lost if this particular appeal were made too frequently. However, the principle still holds that you can explain a problem to present-day employees and thus get help through heads and hearts as well as through hands.

Then there is a sort of left-handed compliment to be paid to this larger sharing of management responsibilities with the men in that there is, on general principles, less bucking of any plan put forth if the men are made to feel that they have a larger place in the picture.

So far I have intimated that certain things in the way of a sharing of management information *may be* done now that employees have a broader vision than formerly. But after all, that is hardly stating the case strong enough. This new viewpoint on the part of labor brings not only an *opportunity* which management may avail itself of, but it seems to me that it also brings a distinct *duty* for management to impart a greater degree of information than formerly.

GETTING THE IDEA ACROSS

But whether it is done as a duty or by choice as an advantageous proceeding, the question of how to "get it across" still faces us all. And like most problems of management, it depends to a considerable extent upon the personal characteristics of the chief executive. Some of us are so made up that we work to best advantage one way, while others succeed best through a different procedure.

For example, some will find that whatever information should be imparted down the line can best be done by individual contacts with the various department heads. Others like to take advantage of the fact that where groups of people are involved, there is a glow of enthusiasm that is not so well kindled by individual contact. To these latter meetings will provide the necessary means.

Perhaps that good old piece of advice which has been so often popularly expressed by the words "Be Yourself" offers the best guide. Personally, I see a large value in imparting the information we have to give through individual conversations with as many people in the organization as possible. I do not mean by this that any opportunity is allowed to pass of selling the activities of the company to the employees who have contributed to them so largely and who can be most effectively reached in group gatherings.

BRANCH PLANTS

In this connection it seems to me worth saying that in companies having branch plants, too little is done toward letting the organizations of these branches know what the other plants are accomplishing. Your own daily relations with all the branches are so much a matter of course that it is pretty easy to assume that each private in your industrial army knows, too, what it's all about. But he doesn't. You may be amazed to find some day that people pretty well up in some of the branch organizations are rather ignorant of what the other fellow is doing. And it's not their fault either. It is pretty largely yours—and mine. So I lose no opportunity in getting about from one of our plants to another to sell *all* of Link Belt's activities to *all* of our men.

MAN-TO-MAN TALKS

While bulletin board notices, pay envelope stuffers, circular letters and the like are undoubtedly of some service in getting across facts to the men, they are, in my estimation, rather poor substitutes for man-to-man talks *with* and not wholly *to* the organization. That's the trouble with notices and letters. They are only half of a conversation at best, and generally, not even half because questions listened to and answered develop new points that should often be explained in considerable detail.

EXECUTIVE RESPONSIBILITY

Of course I am not oblivious to the fact that the taking on of responsibilities of the sort I have been describing may well burden the head of a business almost to the breaking point. So of course the thing has to be done within reason. But the matter is too important to do nothing with on the ground of being "too busy." And it is too important to be delegated entirely to someone else.

I have referred to the desirability of each executive being himself, doing things in his own one best way. When that one best way happens to differ from and therefore supplement the methods of a subordinate executive you sometimes have a very beneficial situation. As an example of what I mean, I know of one concern where certain of the vice-presidents by their very natures find it difficult to explain in detail the policy reasons for this and that company move. In that concern the president, who outstandingly possesses the ability to talk most intimately with any member of the organization, finds it a distinct advantage to go into these particular vice-presidents' departments and make up for the shortcomings of the latter. And he does it in such a way that there is no going over the head of the vice-president. He simply fortifies the vice-president at the point where he is weakest and assistance counts most.

WORKERS RETURNING TO COMPANY'S EMPLOY

There is another situation in management that I believe will stand more "pitiless publicity" than many executives are willing to accord it. I refer to a wider spreading of the information rather than a soft-pedaling of it when an employee who has left the company comes back again into the family. Whatever you do, men are going to get dissatisfied and leave you occasionally. That is just human nature. But in my estimation you are not going to cure it by any hard and fast rules such as some companies have to the effect that a man once leaving of his own accord may not again be employed. You will do far better, it seems to me, if you more or less advertise the fact that a certain employee left on hopes which proved to be false, as they so often do, and is now back again happily located in the organization. This last point is a little bit off of the subject I have chiefly in mind, but after all, it is in the spirit of not trying to withhold the facts, but rather of telling them all, for in the long run truths help rather than hinder.

QUICK CHANGE IN PLANS

Meeting today's sharp competition frequently calls for quick changes in plans. If you are counting upon practically a full revelation to your whole organization of these plans as a means of getting co-operation in their execution there is another factor of great importance. And that is the necessity of getting the information across as early as possible. Information tardily given is only half given. At least so far as any beneficial results are concerned it is only partially given and has little real effect.

For even at best as we all know there is an unavoidable lag—and generally a lag measured in weeks or even months rather than days—between decision and ultimate attainment of results. So if we hope ever to shorten this gap through co-operation of our full organization gained by a revealing of our plans, we should tell what we have to tell as soon as possible. In other words, not only "get it across" but get it across early.

DELAY IS DANGEROUS

And that is just as true in connection with checking existing conditions as with planning new undertakings. If things get to going wrong to any extent before checking them they can slide pretty rapidly. So any report on current conditions which it is desirable to get over to the employees must be imparted while it is still news and not a matter of history. We do not need our employees' co-operation in understanding history but we do need it in molding the future.

A GRADUAL CHANGE

What I have to say is intended as no statement of any suddenly discovered truth nor of a fact which itself has suddenly come into being. Just the opposite is true, for this change in the viewpoint of the man at the bench of which I have spoken has not come about overnight. It has been a long time developing. In fact, that's the very point. It has grown so slowly that some of us little appreciate both its present extent and its potentialities for good in modern management.

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